The Ontario
Task Force on
Employment and
New Technology

FINAL REPORT

Employment and New Technology

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The Ontario Task Force on Employment and New Technology

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September 1985

The Honourable William Wrye
Minister of Labour
Government of Ontario
Toronto, Ontario

Dear Mr. Wrye:

We are pleased to transmit to you the Report of the Ontario Task Force on Employment and New Technology.

As suggested in the terms of reference, we have considered the manpower and employment implications of new technologies as they may be introduced and applied in Ontario over the period 1985-1995. We have focussed our attention upon developing an understanding of where and to what extent future employment changes may occur, particularly those which are associated with technological change.

We hope the Task Force's study of these projected developments provides information which will assist Ontarians in the process of adjusting to the changing circumstances within our workplaces.

Yours sincerely,

William Boggs
Co-Chairman

Robert White
Co-Chairman

Ralph Barford

Jalynn Bennett

Lucie Nicholson

Fred Pomeroy

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Acknowledgements

The Ontario Task Force on Employment and New Technology has been generously supported by financial contributions from:

The Board of Industrial Leadership and Development (BILD)
of the Government of Ontario;
The Ontario Manpower Commission;
The Ontario Ministry of Labour.

The Task force would particularly like to thank those labour leaders and senior managers who participated in the survey of firms which forms a central element of this study. Their willingness to give generously of their time is most warmly appreciated.

Summary of the Work and Findings of the Task Force

Recognizing that traditional job patterns will change as new technology takes hold, the Government of Ontario decided an extensive study was necessary in order that the Province might put itself in the strongest possible position to adjust to these projected developments. Accordingly, the Ministry of Labour and the Ontario Manpower Commission invited industry and labour representatives to join a Task Force on Employment and New Technology, which began meeting in May, 1984.

Initially, terms of reference and research objectives were reviewed and a determination made of the problem to be addressed. The priority of the Task Force was to identify the nature and extent of the impact of technology on employment for the next ten years; that is, to establish how technology will affect the number, mix and type of work-tasks in Ontario. The Task Force was not asked to recommend solutions to any problems that may accompany these developments. Consequently, the potential match or mismatch between supply and demand has not been addressed, and similarly, while identifying changes in industry and occupational employment, the Task Force has not examined institutional responses or policy initiatives which might help the labour force adjust to such changes.

The findings of the Task Force, therefore, are descriptive rather than prescriptive. They attempt to explain where and to what extent employment changes will occur, and provide a strong basis for others to decide what should be done in the future.

To accomplish its mandate, the Task Force has focussed on several dimensions of the relationship between employment and technology:

- Since an informed perspective about the past is needed in order to assess present and future developments, historical employment trends were studied;
- Research pertaining both to past and future employment was conducted at the level of the industry, the industry-sector, and the overall economy in order to consider the impact of technology on employment from several perspectives;
- A survey based on personal interviews studied future employment in key manufacturing and service industries. Some key industries that might otherwise have been included were left out to avoid duplicating similar studies being conducted by others, for example, the study by the Human Resource Task Force on the Automotive Industry. These studies, which formed a central part of the overall research endeavour, focussed on industries which contain large shares of occupations believed to be particularly impacted by new technologies. Included among the new technologies studied were advanced-manufacturing, office automation, computer, and telecommunications technologies. The employment effects were studied on eight major occupational groups spanning work activities of the shop-floor and office;
- Estimates of future employment for all industry-sectors were obtained through a survey of informed sources. In addition, occupational shifts over the past decade were studied and estimates made of future occupational profiles for all industry-sectors. In this way, the effect of technology on skills was measured and estimations made of overall employment and occupational shifts for the future;

- At the level of the overall economy, the effect on employment of additional productivity improvements and changes in technology were examined.

Throughout the research, it was recognized that the relationship of employment and technology is exceedingly complex. Therefore, all the estimates of future employment need to be regarded as that—estimates and not iron-clad facts. Many other factors—social, demographic, economic—in addition to technology, influence the nature and level of employment. Thus, to use the information gathered in an appropriate manner, the Task Force report emphasizes only broad trends that appear consistently. Anybody making further use of the data should likewise be cautious.

The priority of the Task Force was to establish an information base on the effect of technology on employment. The findings, therefore, are restricted to observations supported by quantifiable data presented in the report and appendices. However, there are a number of further implications that are apparent from these findings. Given our mandate, we have not studied these issues and questions, but we have thought it helpful to identify them in the section following the presentation of our findings.

Findings on the Adoption of New Technology, 1985 to 1995

The general feeling in the community has been that new technology will be adopted more rapidly in the future than in the past; so we set out to learn the extent to which new technology has already been adopted, and what plans are already in place to adopt more in the future. In the industries surveyed we found:

- **A significant level of new technology has already been adopted.** Most of the manufacturing industries surveyed had adopted many new manufacturing-related technologies by 1985, and even more service industries had adopted new office-related technologies.
- **Plans for new technology adoption are extensive for 1985-1990, encompassing a greater range of technologies and faster rates of adoption than in the past.** Manufacturing industries will further adopt engineering design, manufacturing planning, manufacturing process, and telecommunications technologies. Service industries plan further extensive use of office automation, customer service delivery, and telecommunications technologies.
- **Plans for 1990-1995 are more difficult to interpret because few of the industries surveyed plan that far ahead.**
- **Larger firms will adopt new technology faster than smaller firms.**
- **Most capital spending for the next five years will be on machinery and equipment rather than buildings, and much of that will be to adopt new technology.**
- **Management and labour agree that:**
  - **unions have not impeded the adoption of technology;**
  - **in general, the external factors that shape organizations really offer little or no choice between adopting it or not adopting it; it has to be done;**
  - **the important questions are more to do with the processes of implementing technological change in ways which effectively and fairly deal with the legitimate interests of all affected parties, such as job security, training, consultation, and sharing of benefits.**

Findings on the Employment Implications of New Technology, 1985 to 1995

We have examined the extent and nature of the employment implications of new technology in Ontario for the future period 1985-1995. We found:

- **The extensive plans for adopting new technology signal substantial employment-related changes for the coming years.**

The implications are twofold:

- the level of employment;
- the changing nature of employment.

Level of Overall Employment

The impact of new technology on employment cannot be separated from a wide range of political, economic, and social factors, such as international trade, interest rates, the state of the economy, labour market participation rates, average working time, and demographic trends, all of which influence the demand for goods and services and hence employment.

We have examined the historical record and found that increasing levels of employment and real incomes have been achieved while significant technological change has occurred. We have also considered the economic circumstances of the last few years, when unemployment rates have been high, and found:

- **The perception that overall unemployment problems necessarily result from technological change is wrong. While employment dislocations will occur with technological change, and are particularly noticeable in industries affected by slow economic growth, we believe that the contribution of technological change to overall employment can be positive.**

Our survey of selected manufacturing and service industries reinforced this view. We found:

- **Most manufacturing and service industries cited economic and market factors as having a greater impact on their levels of employment than the adoption of new technology. However, more service than manufacturing industries cited the adoption of new technology as the most significant factor affecting their future levels of employment.**

With respect to the levels of overall employment for the next ten years, we surveyed a large number of well-informed sources to determine estimates of future employment. We found:

- **There is no evidence that adopting new technology will lead to reduced levels of overall Ontario employment over 1985-1995. However, the rate of new job creation expected for the coming decade will be lower than in the 1970's.**

We also commissioned macroeconomic studies of the employment outcomes from technological change in the context of the overall economy. The studies revealed that:

- **Future levels of overall employment are influenced by the way in which the productivity dividends resulting from technological change are distributed in the economy; actions by business, labour, and government can affect this distribution.**

The Changing Nature of Employment

While the level of overall employment is expected to increase over the next decade, there will be major changes in the employment levels of some industries and in both the employment and skill levels of some occupations. These changes will have wide-reaching consequences for industries and labour force participants. We found:

- **Employment growth patterns for industries and occupations will be significantly different in the coming decade. There will be employment disruptions in some industries and occupations as new technology continues to be adopted.**

Changes in Industry-Sector Employment

Information gathered from a variety of well-informed sources indicates that extensive changes in industry-sector employment growth patterns will occur for the 1985-1995 period. We found from our industry-sector studies:

- **Significantly different patterns of employment growth by industry will occur over the next decade.**
- **Employment will grow in almost all industry-sectors though for many at much slower rates than in the 1970's.**

- Service-related industry-sectors are expected to account for approximately 80 percent of all new jobs, although their rates of employment growth are also expected to be lower than in the past.
- While employment growth is expected to be concentrated in service-related areas, economic growth in the manufacturing and other goods-producing sectors will still be essential in order to sustain this trend.
- The largest contributor to employment growth during the next decade is expected to be the Community, Business and Personal Services sector, which will contribute more than one-half of all new jobs. Within this sector, Services to Business Management (in particular, Computer Services), Accommodation and Food Services, and Amusement and Recreation Services are expected to contribute significantly to employment growth. Education and Related Services will have a declining share of employment growth.
- Many industry-sectors will contribute significantly less to employment growth than during the 1970's. Examples are: Trade; Finance, Insurance and Real Estate; and Public Administration. Manufacturing industry-sectors will contribute only about one-half the number of additional new jobs that they created in the 1970's.
- The proportion of part-time jobs has increased substantially in recent years. However, the results from our survey of selected industries suggest that only modest increases in part-time work are expected for the next decade.

Changes in Occupational Employment and Skills

Changes in employment growth by industry-sector necessarily alter occupational requirements. In addition, changes in occupational employment result from industries adopting new technology and needing different skills. From our industry-sector studies, we found:

- Significantly different patterns of occupational employment growth will occur over the next decade.
- While employment in all major occupational groups will grow during the next decade (except Teaching), five major occupational groups are expected to account for about 70 percent of overall employment growth. They are: Clerical; Service; Natural Sciences, Engineering and Mathematics; Managerial and Administrative; and Sales. Even so, the Clerical group will have a significantly smaller share of employment growth than in the 1970's.
- Of the major occupational groups, only two — Natural Sciences, Engineering and Mathematics; and Service — are expected to account for a significantly larger share of overall employment growth during the next decade than in the 1970's.
- Most women in the labour force are presently concentrated in three occupational groups: Clerical, Sales, and Service. Of these, only Service jobs are expected to gain in their share of overall employment in the next ten years. While there will be employment growth in Clerical and Sales occupations, it will be substantially lower than in recent years. Women will experience considerable impact from these shifts of occupational employment.

From our survey of selected manufacturing and service industries we found:

- Generally, firms believe that the adoption of new technology will require employees to have more skills. More training will be needed to achieve proficiency, and employees will need to know more about their organization's operations.
- A wide range of managerial, professional, technical, and skilled trades personnel were identified as needing more skills and more training to do their work in the future. Many industries expect shortages of these people.
- At the same time as the economy will be needing more highly-skilled people, our industry-sector studies show there will also be an increasing demand over the next decade for relatively lower-skilled workers, such as service workers in fast growing service industries.

- Occupations identified by the service industries as likely to be in oversupply in the next decade are almost exclusively Clerical, and this appears to be closely linked to plans for new technology adoption. We note the majority of persons employed in the Clerical occupations are women.
- To deal with situations of occupational oversupply, firms say they prefer to rely on attrition and retraining, rather than lay-offs.

Further Implications

The Task Force's mandate restricts our findings to observations which are directly supported by quantifiable data as presented in our report and its appendices. However, there are a number of important further deductions which follow from our findings, and, while it has not been appropriate for us to study or suggest answers to these questions since they relate to labour supply and policy responses, we believe it is important for us to identify these issues.

In general, our findings see the coming decade as being characterized by:

- slower growth of overall employment;
- faster adoption of new technology;
- changing patterns of industry and occupational employment growth.

These general findings raise the following issues:

- The changing employment growth patterns, with demand growing simultaneously for highly-skilled workers and relatively lower-skilled workers and shrinking demand in areas such as clerical work, have important implications for labour force participants and for skill development policies and initiatives. Both the individuals preparing for entry or re-entry to the labour market, and those industries and institutions providing skill development and training will need to assess these patterns.
- Slower overall employment growth and shifts in occupational demand may signal more difficult adjustments for displaced workers, and this raises the question as to whether employee adjustment measures for dealing with skill obsolescence are sufficient. In our survey, while retraining was frequently cited as a preferred course of action to deal with occupational oversupply, the proportion of training costs in relation to total labour costs in some industries appears to be too low to match the apparent needs.
- Women are expected to be significantly impacted by shifts in occupational employment. This raises questions regarding the extent to which the impact may be influenced by the numbers of women expected to enter the labour force, by the degree to which women are able to diversify their employment into skilled managerial, professional, technical and trades occupations, and by training opportunities structured to deal with their special concerns.
- Slowing employment growth and shifting patterns of demand for skills imply that more planning will be necessary to effectively and fairly deal with organizational and employment adjustments. In order to address employment opportunities and challenges for the future, it would appear that more attention needs to be paid to human resource development and planning.

CHAPTER 1 1 1 1

The Task Force's Mandate and Research Strategy

Chapter Contents

1.1 Introduction

For western industrialized nations the decade of the 1970's was one of great economic turbulence: successive oil pricing shocks threw the cost structure of many industries into disarray; high rates of inflation caused major hardship for some, and uncertainty for all; international trading competition from eastern and other newly-industrializing countries raised major questions regarding the location of production facilities for multi-national manufacturers; and astronomically high interest rates, sustained by tight monetary policies, conspired with other factors to precipitate a deep and painful recession with extremely high levels of unemployment. It was from the depths of the recession that concerns about technological change and its effect on employment first drew significant public attention.

Since work remains the most central and important institution in our society, any factor which has the potential to substantially alter patterns of work is likely to be a subject of wide public interest. Initially the debate regarding technological change appeared reminiscent of concerns raised in the early 1960's about unemployment and the spread of computer technology and automation. But as employment growth during the economic recovery proceeded at a slow pace, the debate gathered momentum.

Though substantial technological change has been achieved during this century with rising levels of employment, some suggest that the new technology which is currently at hand is different. It is now popularly held, for example, that applications of microelectronic and information-related technology will have significant effects on the developing labour market. Not only will this new technology influence the style and nature of our working lives, but there are concerns expressed by some that in contrast to the past the extent of future work-tasks will be reduced by the new technology.

These concerns appear to be driven by a number of underlying assumptions, some of which are connected with the nature of the new technology, and some of which are related to the economic context in which technological change is now occurring:[1]

- First, the new microelectronic technology is perceived as having the 'intelligent' functional capability to substitute for human mental activity, which makes it different from earlier technology;
- Second, the nature of the new technology is such that it may affect occupational activities in which a large majority of the labour force is employed;
- Third, the rate at which the new technology is being applied is popularly perceived as being faster than the adoption of earlier technology, giving rise to fears that orderly adjustment of the occupational structure may prove difficult;
- Fourth, given the long and dismal recessionary experiences of the past few years, the general economic situation has encouraged the popular belief that the value

1 Peitchinis, S. "Employment in the Evolving Information Economy." Royal Society of Canada. Conference on the Information Economy, Toronto, 1984.

of goods and services to be produced is relatively fixed, and that the amount of work to be done is also relatively fixed. Therefore, any new technology which would make it possible to produce a larger economic output per unit of work-time is perceived as making it possible to produce a fixed volume of output with fewer workers; and

- Fifth, there has developed an ill-founded but a popular tendency to over-generalize the employment effects of applications of new technology from particular cases up to the level of the whole firm, the industry, and even to the level of the overall economy. Consequently, there is a poor distinction drawn between employment effects at the shop-floor level where technology is implemented, and the effects on the overall economy.

In a situation where few facts are known, public debate regarding the future employment effects of technological change includes a complete spectrum of opinions, from pessimistic to optimistic, but with little contribution to informing the underlying concerns of people.

Persistently high rates of unemployment add a note of urgency to an examination of these concerns, and a determination of the real situation associated with the underlying factors.

Accordingly, in 1984 the Government of Ontario established The Ontario Task Force on Employment and New Technology, a joint labour-management group, to conduct a study of the likely extent and nature of the employment impacts associated with new technology.

During the past year, the Task Force has conducted numerous studies related to technological and employment changes in Ontario. Historical patterns of change have been studied to provide an informed perspective from which to view the outlook for the future. Studies have also been conducted to examine the likely employment effects of technological change for the future period 1985-1995. These studies have been conducted at different levels of aggregation in the economy, where different employment effects connected with the same technological change processes are visible, and span the shop-floor level to that of the overall economy.

This report describes these studies and presents the findings of the Task Force on the likely extent and nature of the employment impacts associated with new technology in Ontario for the period 1985-1995.

1.2 The Task Force's Mandate and Focus of Activity

The Government of Ontario has identified the economic importance of new technology being created and adopted by business and industry, and has encouraged the creation of new technology-based industries and the rapid diffusion of new production technology throughout existing industries.[2]

It is therefore taken as a starting point for this study that the commercialization of new products, and the adoption by business and industry of product and process innovations, are activities of vital necessity which could have a significant impact on the structure and productivity of the economy over the next decade.

The Government of Ontario has recognized the potential social consequences of these developments, and has identified the need to prepare for change:

> ". . . as new technology takes hold, traditional job patterns will change and, in some cases, disappear. This, in turn, will give rise to significant changes in the style and nature of life for many Ontario citizens . . . (the) Government intends to undertake an extensive and serious study of these projected developments so that we are in the strongest possible position to assist Ontarians to adjust to the changing circumstances within our industrial and business sector . . ."[3]

2 Grossman, L. *Economic Transformation: Technological Innovation and Diffusion in Ontario.* Ontario Ministry of Treasury and Economics, March, 1984.

3 Speech from the Throne. Legislature of Ontario, 1983.

Accordingly, in May 1984, the Ontario Task Force on Employment and New Technology was established.

The Task Force, a joint labour-management group, was requested:

> "to consider and report on the manpower and employment implications of new technologies as the same may be introduced and applied in Ontario during the next decade and the extent and nature thereof."[4]

In deciding how best to meet this objective, the Task Force recognized that the employment impacts of technological change is a complex subject, particularly in regard to its interconnectedness with other important economic factors. The Task Force also noted that employment-adjustment policy issues cannot be discussed in an orderly fashion without information which adequately describes likely future employment developments. Since these data do not presently exist, it was agreed that the Task Force could most usefully focus upon a careful study of the likely extent and nature of the employment impacts associated with new technology for the coming decade. The activities of the Task Force are therefore descriptive rather than prescriptive, and focus more upon developing an understanding of where and to what extent future employment changes may occur, rather than attempting to provide answers as to what should be done about them.

1.3 The Nature of Technological and Employment Change Processes

In order to define our terminology and to provide a rationale for our approach, we first present an introductory discussion of the nature of technological change and the associated employment adjustment processes.

In the light of this discussion, we shall subsequently describe the research strategy followed by the Task Force.

1.3.1 The Nature Of Technological Change Processes

Science, Engineering, Technology, and Technological Change

Science and the results of engineering in the form of technology have unambiguously demonstrated a capacity to effect major social and economic change.

The observations of science seek to describe the logical connections between the properties of objects. As expressed in the laws and effects of the physical world, science has established some of the great unifying ideas and concepts for viewing our surroundings.

The central activity of engineering is the process of design, a uniquely human creative activity which seeks to find new combinations of things so as to effect changes in our physical surroundings.[5] It is by combining ideas, concepts, things, and properties of things, in new ways and with different orders of logic that new inventions, results, and effects are found. Technology is the result of engineering in the form of man-made artifacts, processes, systems and know-how. Technology, by its very existence, becomes a spur to further scientific investigation, and the engineers of today's world have developed a proficiency in the art of creating new technology to a degree where the results are prodigious by any scale of judgement.

The adoption of new technology in our society is determined by a variety of social, economic, and political factors as individual consumers and all organizations of business, industry and government make judgements regarding the values of new technology.

Importantly, from an economic standpoint there are two principal functions of technology: first, to improve efficiency in the production of existing products and services, and second, to produce new products and services to fill better some social need, or meet a need not previously met or perceived.[6]

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4 Order in Council (O.C. 1474/84).

5 Brown, R. L. E. "Canada's High Priority: Managing Technology to Convert Society's Needs into Profitable Opportunities." *Canadian Research*, October, 1981.

6 Brooks, H. "Technology, Competition, and Employment." *The Annals of the American Academy of Political and Social Science*, Vol. 470, November, 1983.

Technological change is a process which spans both the creation and the adoption of new technology. The creation of new technology requires the activities of research, design, and development. The adoption of new technology is driven by judgements made by organizations and individual consumers as they take up newly-created technology. Individual consumers make value judgements in marketplaces about the relative importance which they attach to new technology available in the form of new goods and services. These judgements fundamentally affect the rate of technological change. In similar fashion, all organizations of business, industry and government adopt new technology as they choose the means to produce and deliver their outputs; thus, manufacturing organizations adopt new production technology to assist in their production of goods, and service-oriented organizations adopt new technology to assist in their delivery of services.

Technological change is therefore a process which embraces the creation of new technology, manifest in the form of new products, processes, systems, and know-how, and its adoption by individual consumers and by the organizations of business, industry, and government.

Technological Change Processes for Business, Industry, and Government

In our modern society many organizations create new technology, and all successful organizations adopt new technology in their efforts to reach their goals.

In those organizations of business and industry which deliver their outputs into competitive marketplaces, such as all primary and secondary manufacturing industries and many service-oriented industries, the need for effective use of technology in so far as it contributes to competitive success is well established. The natural survival mechanisms of the marketplace have always encouraged the existence of competitive organizations capable of creating new technology in the form of new products, and of making efficient use of new technology in the production of their outputs.

Opportunities for the creation of new technology are constantly arising from changes in new scientific knowledge and changes in the economic environment. As these opportunities become recognized, some will be selected and used for the generation of new products and processes. In competitive sectors of the economy, an important consideration in the selection of opportunities will be expected profitability. Firms compete with each other to place new products of goods and services on the market, or to gain market share by adopting new cost-reducing processes as they attempt to stabilize or lower costs of their existing products. This competitive process will have winners and losers. Some firms will introduce new products and processes before others; some firms will be newly-created on the basis of new technology, and others will die as the competitive struggle leaves them behind. An analysis of this process suggests that the need for organizations to succeed in order to survive will lead the design and development of new technology into directions where the chances of success are greatest.[7] Thus, the new processes developed are likely to be those yielding greatest cost reductions, and the new products are likely to be those with the greatest market potential.

As new technology is adopted by producers, their costs of production will change and they may choose to alter their prices so as to affect their market share, thus potentially yielding savings to the producer and to consumers. In addition, as new technology is adopted by producers, their mix of input requirements for production will change and they may require different and possibly additional inputs from other firms. As new technology usually needs to be manufactured and serviced, there may well develop new industries producing these new goods and services, all developing, changing, and maturing over time. As the producing industry grows in response to the demand for its products, so will investment take place and its employment level increase.

Users of new technology will tend to select those products and processes that have the highest rates of return on capital investment. These returns depend on expected revenue and cost changes, and on prices being charged for new technology. The price of new technology and its cost savings when in use, will affect its

7 Stoneman, Paul. *The Economic Analysis of Technological Change*. Oxford University Press, Oxford, 1983.

speed of diffusion throughout the overall economy. As new technology is adopted, changes therefore occur in the sizes of firms, the competitive structure of industry, its outputs and prices, and its labour and capital requirements.

As new technology is used more widely, so the average costs of production should fall, and the potential arises for savings to consumers. At the same time, the use of new technology can yield profit to its owners. As the new products and processes are being used, so the old are being replaced, which implies the decline of old industries. As new firms arise and old firms die, as industries rise and fall, so the demand for labour will be subject to a continual recomposition in terms of level, skill and occupational requirements.

Thus, as new technology in the form of new products, processes, systems and know-how is diffused throughout the economy, so prices, incomes, employment, and trade are affected. As the technological change proceeds, so the economy develops. Output, employment, investment, income distribution, and market structure are thus all being affected by, and in turn are affecting the creation and adoption of new technology.

In organizations delivering services where there is little or no competition, such as in government service, in other service organizations dominated by public funding, and in monopolies heavily influenced by public regulation, technological change processes are affected by different forces and may have a different dynamic than in other business and industry.

It has long been recognized that the allocation of resources according to what firms regard as profitable is a fundamentally important process. However, we know that it does not ensure the array of technological development so funded is complete with regard to the provision of services necessary for our modern-day society. Thus, for example, in areas involving health, transportation, and the environment, most countries do not solely rely on the market mechanism to provide service to the community. There is, therefore, an important role for publicly-administered bodies to play in the creation of new technology relevant to such areas.

Furthermore, somewhat analogous to the production activities of business and industry, publicly-administered bodies adopt new technology so as to extend their range and quality of service, and to make more efficient the delivery of all their services.

In many instances the nature of services requested by the public is inextricably tied to the existence of new technology, and the extent of services provided is determined by a political process involving potential recipients of services, elected representatives, and the bureaucracies of provider organizations.

In this way, the mix of forces causing change and the process of technological change are somewhat different in publicly-administered bodies than in competitive, profit-making organizations. However, to the extent that the bureaucracies of public service organizations are driven to justify, stabilize, or even reduce the cost of their services, so the nature of their technological change processes, and in particular their process for adopting new technology, will be disciplined by similar concerns and assume similar characteristics to the production activities of other types of organization.

1.3.2 The Nature Of Employment Changes Resulting From New Technology

The most immediate employment-related effect resulting from the creation and adoption of new technology is to change the work available to people; that is, the number, type, and mix of work-tasks which need to be done.

A recent analysis shows the relationships between the creation and adoption of new technology and the ensuing work changes are complex.[8] There are work changes which are directly associated with the creation of new technology, and work changes which directly result from the adoption of new technology; these are usually straightforward to identify. However, there are also work changes of an indirect nature which may be difficult to identify, and even more difficult to quantify, though they are known to exist and may be substantial.

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8 Blumenthal, M. S. "Programmable Automation and the Economy." Society of Manufacturing Engineers, World Conference on the Human Aspects of Automation, Montreal, September 1984.

Type and Mix of Work-Tasks

It is now well established that the creation of new technology in the form of new products, processes, systems and know-how, has been encouraged by the deliberate management of the knowledge and skills of highly-qualified human resources toward that end. Thus, as the importance has become more apparent of the contribution which new technology can make in assisting all organizations to reach their goals, so has grown the number and type of work-tasks in our society associated with the creation of new technology.

While the creation of new technology is an activity of undoubted importance, a subject of even greater importance, as judged by the numbers and variety of people affected, is the way in which new technology is adopted. Some employers have some employees involved with the creation of new technology, but most employees of most employers are affected by the adoption of new technology.

As organizations adopt new technology, the changing patterns of work-tasks which result are complex, and by no means obvious. When new production technology is adopted, work-tasks may be directly displaced which might otherwise have been available. Equally, if production costs are stabilized or lowered, or product quality is raised, it is likely that production volume may need to be increased to satisfy additional demand, and net additional work-tasks thereby created. However, it is more difficult to identify and quantify what happens to work-tasks indirectly affected in other firms and industries as the result of this adoption. The adoption of new technology will give rise to new types of work-tasks, such as those associated with the production and support of the equipment and systems in which the new technology is embodied, and these additional tasks may be in different industries than the adopting organization. In addition, the adoption of new technology will enable the making of new products and the provision of new services not previously possible or recognized, which, in turn, provides a demand for additional work-tasks.

Work-Tasks and Skills

As new technology affects the type and mix of work-tasks which need to be done, it also affects the skill requirements associated with these tasks. The direction and nature of these skill changes are also not always obvious.

It is clear that the creation of increasingly complex new technology requires the application of increasingly sophisticated skills. This is usually evidenced by the growing need for scientific, technological, managerial, and other highly-qualified human resources in organizations where the activities of new product, process, or know-how creation have been recognized as being central to success.

However, the skill changes which accompany changing patterns of work-tasks are less obvious in organizations adopting new technology. Sometimes new work-tasks will require additional and more sophisticated skills. However, sometimes the reverse will be true and the adoption of new technology will eliminate the need for certain skills. Sometimes both may simultaneously occur in the same organization as the required skills are redistributed across jobs. To make this situation even more complex, the changing skill requirements may not appear in the organization adopting the new technology, but elsewhere, and often even in different industries.

The nature of the new work-tasks accompanying new technology may demand a deeper understanding of specialized knowledge; this will likely be evidenced by more time being required for the education and training of those seeking proficiency in the necessary skill. In other situations, the opposite may be true and a reduced level of skill requirement may only need lower levels of training. The redistribution of work-tasks accompanying technological change may also imply for some jobs a broadening of skills across a wider perspective of disciplines.

Changing Patterns of Work-tasks, Skills, Jobs and Occupational Trends

As work-tasks are affected by new technology, it is likely, though not axiomatic, that the number and content of jobs will be changed. The allocation of work-tasks in a firm is a function of management, and there are often alternative arrangements available which can affect the numbers and content of jobs.

As work-tasks change, firms may have additional and new skill requirements. These may be met from within the existing workforce by steps such as retraining, upgrading, or more overtime. The additional requirements may also be met from outside the existing workforce by steps such as new job hirings of full or part-time people, or by contracting with other organizations for the provision of services.

On the other hand, work-tasks may change so that firms find themselves with a

surplus of skills. In such circumstances, firms may choose between a range of alternative actions. Management may choose to reduce the size of their firm's workforce by attrition, early retirements, or layoffs. As an alternative, management may choose a strategy of adapting the skills of its workforce, and methods could include: shorter hours or work-week, job-sharing, change some full-time people to part-time, retraining, transfer people to other plants, and reclassification of jobs.

Importantly, as evidence is sought of the effects of technological change, over the longer term the changing nature of work-tasks will result in measurable occupational trends. These will be industry-specific, and the changing occupational composition of that industry's workforce will reflect the changing nature of that industry's technology.

People and Technological Change

Finally, at the risk of stating the obvious, it should be noted that the nature of the technological change process is determined by people. New technology is not an end in itself. Its value in our society is reflected in the adoption processes involving both consumers and adopting organizations. The extent, the rate, and the manner in which the adoption proceeds, in aggregate, or locally in any particular organization, is determined by a complex array of social, political, and economic factors.

At the level of the firm, competition and efficiency of operation are not the only determinants of technological change.[9] Although these factors are ever present in the eyes of firms' management, there may be alternatives available regarding the means for achieving goals. Thus, while the adoption of new technology is likely to be part of a continuing management strategy aimed at organizational success and growth, these goals may be achieved by processes in which alternatives are considered, and opportunities are provided for participants to minimize stressful outcomes. Managers, engineers, and workers become involved in orienting the impact of new technology in particular directions. Coping with technological change tests the roles, rights, responsibilities and mutual relationships of management and workers. It is widely understood by all affected parties that the external factors which shape organizations really do not offer in any practical sense a choice between adopting new technology or not adopting new technology. The important questions are therefore more to do with the processes of implementing technological change in ways which effectively and fairly deal with the legitimate interests of affected parties. There are likely to be conflicts of interest between affected parties which may be expressed openly, and sometimes vigorously. Clearly, the extent to which this occurs will be related to the magnitudes of adjustments involved in the technological change process. While there are likely to be conflicting interests between affected parties, there are also common interests which can form the basis for co-operative approaches. The use of new technology in production systems, whether office or factory-oriented, often demands a matching of organizational and managerial change, as work-tasks are redefined and reallocated, and the extent to which this is successfully achieved will clearly depend on the capacity of all parties affected to share common objectives and to utilize adoption processes which reflect the differing but legitimate concerns of those affected.

1.4 The Task Force's Research Strategy

The extent and nature of work-tasks in our economy clearly depend on a variety of factors in addition to those of a technological nature. As we have noted, output, employment, investment, income distribution, and market structure are all being affected by, and in turn are affecting the creation and adoption of new technology. Since the relationships between these factors are often understood only in qualitative terms, great care needs to be exercised in any study of the employment impacts of technological change. In our study, the employment implications of technological change will be discussed only to the extent of the precision and certainty of the methodology at hand. This should of course be true in any study, but in our case becomes even more challenging since we are not only dealing with factual evidence from the past, but also with the uncertainties of future events.

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9 Wilkinson, Barry. *The Shopfloor Politics of New Technology*. Weinmann Educational, 1983.

The development of appropriate methodology for the conduct of such studies is still in its infancy. The subject is of relatively recent interest to researchers, and those important studies which have been completed recognize the limitations of existing methodology.[10,11]

Our approach has utilized a strategy in which an initial review of past labour market trends has been conducted. Then, for the future time period of 1985-1995, a number of related studies have been conducted at different levels of aggregation in the economy. Each of these studies has carefully been undertaken with due regard to the extent of the wider generalizations which can appropriately be made of the results.

Our reasons for having used this strategy are outlined as follows:

History as a Guide to the Future

An examination of recent labour market trends is an essential first step. It is important that we know where we are now, and how we got here, if we are to have any hope of saying where we are likely to go in the future.

Recognizing that technological change processes have been continually occurring in the economy over all previous history, we might have been tempted to concentrate our attention only on a study of the past. Such an approach would, however, miss the concern that the nature of the new technology at hand is different to technology adopted in the past.

An appropriate methodology is certainly one which draws upon the guidance of past economic and labour market performance, giving particular emphasis to data from recently past years. But in addition, an appropriate methodology goes beyond the analysis of past facts, and requires the gathering of information from areas where extensive changes are currently occurring and from areas where changes are planned and therefore likely to occur during the future period in question.

Studies of Firms and Industries, Industry-Sectors, and the Overall Economy

From the earlier discussion of the nature of technological change it is clear that the employment impacts which may be seen as being associated with technological change depend very much on an observer's position for viewing the change process.

Observers positioned at the level of the firm, or at the levels of the industry, the industry-sector, or that of the overall economy, may see quite different effects when viewing activities connected with the same technological change process. Observations from different viewpoints may appear at first sight to be contradictory, even though in fact they are consistent but different parts within a larger overall picture. For example, while overall employment may be increasing, one industry may be increasing in size and another may be declining for reasons connected with the same technological change process.

To gather a complete and well-informed picture of the effects of technological change distortions must be avoided which might arise by choosing too narrow a range of observational perspectives.

In studying the employment impacts of technological change important observational levels are those of the individual firm and industry, for it is at these levels that employment changes are visible in human terms and we can talk with people who have first-hand knowledge of what is occurring and what is planned to occur. However, since it is clearly impractical to study all firms in such detail, care must be exercised in choosing which particular firms and industries to observe, and in the way we gather information from them, if we are to derive information on a basis which will permit wider generalizations.

However, since it is necessary to describe employment and occupational changes for Ontario, a framework which permits aggregation of industry data is required. For our Task Force this has been practical at the industry-sector level.

Further, there are factors at work in the overall economy whose effects are not readily apparent in the examination of individual units. For example, it is quite possible for a firm or an industry to decline. But it is more unlikely for this to happen to

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10 Hunt, T.L. "Robotics, Automation and Jobs: 1984 and Beyond." Society of Manufacturing Engineers, World Congress on the Human Aspects of Automation, Montreal, September, 1984.

11 Leontief, W., Dunchin, F. *The Impacts of Automation on Employment 1963-2000*. Final Report to the National Science Foundation, Institute for Economic Analysis, New York, 1984.

a whole economy, because if a whole economy is affected by low demand and unemployment, then wages, prices, and perhaps the exchange rate and monetary and fiscal mechanisms will all begin to respond. Thus, to get a picture of the impact of technology on employment as a whole, we also need some kind of overall analysis which takes into account the economy-wide equilibrating-mechanisms not readily apparent in more detailed studies.

In order to establish a picture of the extent and nature of employment impacts associated with technological change, it is therefore necessary to use a methodology which makes observations from different vantage points, spanning the levels of the firm and industry, industry-sector, and overall economy.

For these reasons the Task Force has therefore pursued the following strategy:

- First, a review of employment and labour market trends has been conducted to determine what our experience of the recent past may offer as guidance to the future employment effects of technological change.
- Second, with the possibility that the past may offer only limited guidance to the employment effects of future technological change, an original research program has been conducted to gather information from various sources on likely future employment patterns for the 1985-1995 period.

  This research program includes:

  - Studies of selected firms and industries;
  - Industry-sector studies;
  - Studies of the overall economy.

1.5 The Structure of the Final Report

The structure of this Final Report reflects the process used by the Task Force to carry out its work. First, the Task Force undertook its program of research studies. Next, on receipt of the results, summaries of important elements of these studies were prepared for this Report. Finally, the Task Force reviewed all materials to deduce its Findings.

The Final Report is therefore structured in the following order:

- A Summary of the Work and Findings of the Task Force are presented at the front of this document.
- Chapter 1 provides a general introduction to the process of technological change and its impacts on the extent and nature of employment.
- Chapters 2-6 present summaries of important elements of our research studies:

  - In the next chapter, Chapter 2, we present an historical review of employment changes from 1910 up to recent times;
  - In Chapter 3, we present an introduction to the major elements of our research program regarding the future period, 1985-1995;
  - Then we sequentially present summaries of the results from this research in Chapters 4, 5 and 6, which respectively present results from our industry, industry-sector, and studies of the overall economy.

- Details of the studies on which the foregoing is based are provided in twenty separate Appendices, which are listed at the rear of this document.

C H A P T E R 2 2 2 2

Employment and Technological Change: 1910 to Present

Chapter Contents

2.1 Introduction

A variety of demographic, social, technological, and economic forces shape Ontario's labour market. As one important factor, technological change has significantly contributed to the shifting patterns of work-tasks in Ontario.

In this chapter we examine the historical record to determine what our previous experience may offer as a guide to the future effects of the continuing processes of technological change. Importantly, this review establishes where we are now, and how we got here, which are necessary in order to provide an informed perspective from which to view the outlook for the future.

As we examine the historical record, we do so with the following questions in mind:

- What relationships between overall employment levels and technological change are suggested by the long-run historical record?
- What important labour market trends have developed in Ontario during the post-war period?
- Importantly, since technological change affects the tasks which need to be done in our workplaces, what occupational employment patterns have appeared in the recently past decade?
- As we emerge from the depths of the recent recession, what labour market trends have become apparent?

We proceed to address these questions sequentially. The chapter is therefore subdivided so as to deal with different time periods of the historical record, and at different levels of data aggregation. Thus, we first deal with the long-run historical record, and then we describe more recent and detailed labour market trends.

2.2 The Overall Record: 1910 to Present

In this section we review trends in employment-related data which have developed over this century in the Canadian economy.

2.2.1 The Extent of Technological Change

First, we remind ourselves that over the course of this century we have experienced tremendous technological changes. Table 2.1 lists selected major technological changes by industry-sector which have been adopted during this century.

Although we do not suggest that the list is by any means complete, nevertheless it is sufficient to remind us that the technological changes which have already occurred during this century have been truly astounding. The extent of these changes is even more remarkable when one considers the adjustments which have been required and accommodated by the labour market.

2.2.2 Employment and Output Growth

Figure 2.1 shows the levels of employment and economic output achieved over the 1926-1983 period. The time-trends of employment and output are traced by indices derived by a process of dividing the value of the variable for each year by the value which it had in 1926 at the start of the time series. Thus, for example, we see that economic output, as measured by the total value of all goods and services produced in constant dollars, has increased by a factor of approximately 9.5 over the 1926-1983 period, and overall employment has increased by a factor of approximately 3.

We note the following: First, in general, over a very long period of time, output and employment have steadily increased. Second, increasing levels of output have been produced per employed person; this is evidenced by output increasing at a faster rate than employment. Third, these long-run trends of increasing output and employment have been established at the same time an astounding amount of technological change has been accommodated. There is, therefore, little evidence in the long-run historical record which suggests technological change has posed a threat to overall employment levels.

Table 2.1 **Selected Major Technological Changes, 1910 to Present**

Agriculture	Chemical fertilizers; herbicides; selective breeding; combine harvesters; tractor-implement systems.
Forestry	Chainsaws; skidders; forest management techniques.
Mining	Rock drilling and blasting techniques; rock beneficiation processes.
Food Processing	Milk processing; frozen foods; freeze-dried foods.
Textiles	Synthetic fibres; dyestuffs.
Paper and Printing	Chemical pulping; photo typesetting; xerography
Primary Metal and Metal Fabricating	Alloy steels; non-ferrous metals; continuous casting processes; high-speed metal cutting tools.
Motor Vehicles	Development of internal combustion engine; assembly-line manufacture; pneumatic tyres.
Machinery	Power hand tools; construction machinery; outboard marine motors; numerically-controlled machine tools; lift trucks; refrigeration and air conditioning equipment; household appliances.
Electrical Products	Television; transistors; electric typewriters; long-playing records; hi-fidelity sound systems; radar; microwave-transmission; microelectronics; computers; signalling systems.
Chemical	Polymers and plastics; pharmaceutical compounds; antibiotics; oral contraceptives.
Construction	Steel reinforced concrete.
Utilities	Nuclear-fueled electrical generation; long-distance electrical power transmission; oil and gas pipelines.
Transportation	Aircraft; trucks; diesel locomotives; unit trains; container shipping; gas turbine engines.
Communication	Telephone systems; picture, voice and data transmission systems; satellites; movies.
Trade	Supermarkets; packaging; point-of-sale technologies.
Finance	Data communication systems; electronic funds transfer systems; credit cards.
Community, Business and Personal Services	Immunization; diagnostic medical technology; anaesthetics; television in education; computers in education.
Public Administration	Highway construction technology; water treatment; effluent disposal technology; air-traffic control.

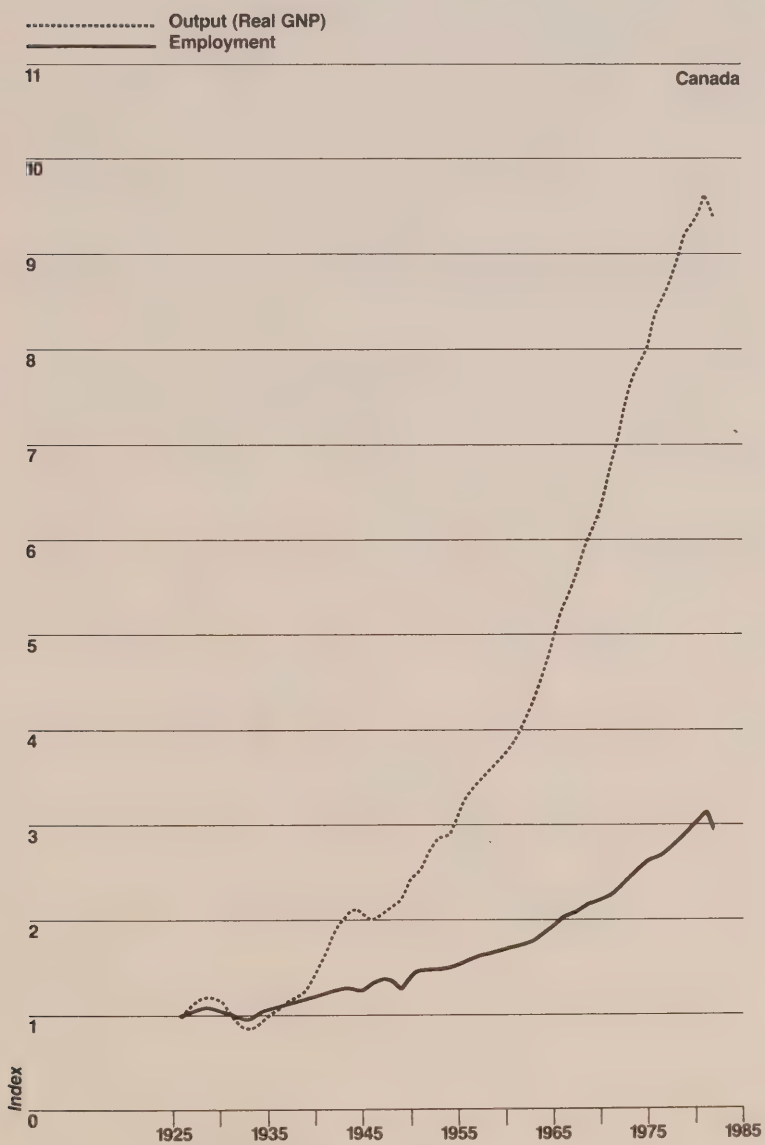
2.2.3 Trends in Salaries, Wages and Productivity

Figure 2.2 shows long-term trends in wages and productivity; the data presented for wages are indices of total real national expenditures on salaries and wages per employed person, and the data for productivity are indices of total output achieved per employed person.

It is important to note that the real wage expenditures per employed person increased steadily over the post-war period up to the early 1970's, and at a faster rate than increases in output per employee. Thus, over the same time period during which substantial technological change and productivity improvements occurred, real salaries and wages also substantially increased.

The historical record is therefore one of increasing overall employment and real incomes achieved while enormous technological change has occurred. This suggests the process of technological change has been an integral and necessary activity in order to achieve rising employment and income levels.

Figure 2.1 **Output and Employment, 1926 to 1982**



Source: *Historical Statistics of Canada*, 2nd Edition

2.2.4 Industrial Distribution of Employment

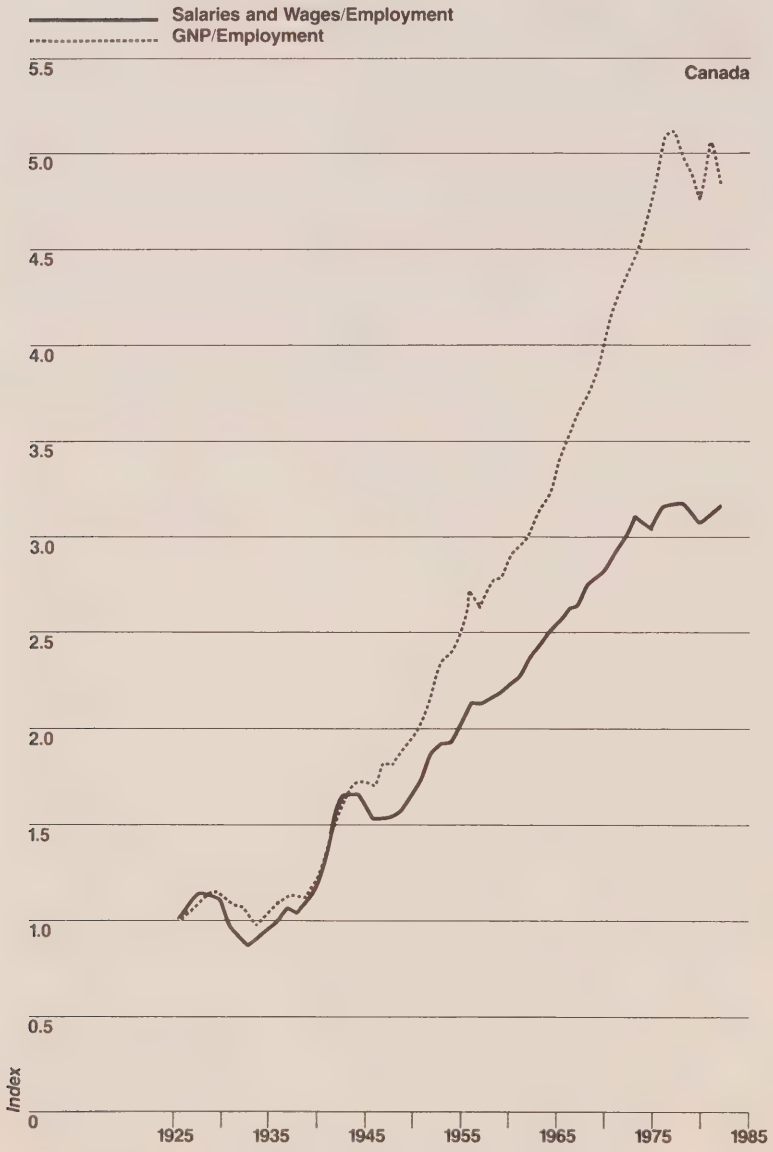
Technological change has driven major changes in the mix of work-tasks that the employed population has performed, and we shall later examine this in detail. Here, we shall note the major change that has evolved this century regarding the industrial distribution of employment.

As shown in Figure 2.3, in 1911 approximately 39 percent of the workforce was employed in the primary goods-producing industries of Agriculture, Fishing, Trapping and Mining; by 1981 this proportion had fallen to just 7 percent.

Over the same period, the proportion of overall employment found in service-related industries, such as Communication, Trade, Finance and Insurance, Community, Business and Personal Services, and Public Administration, increased from 33 to 64 percent.

The proportion of overall employment in the secondary goods-producing industries, including all Manufacturing industries and Construction, has stayed much steadier over this time period. In 1911, 25 percent of the workforce was employed in such industries; the proportion declined modestly during the 1920's, rose during the 1930's and the Second-War to a maximum of 32 percent in 1951, and from there declined to its recent, 1981, value of 24 percent.

Figure 2.2 **Productivity and Incomes, 1926 to 1982**



Source: *Historical Statistics of Canada*, 2nd Edition

2.2.5 Economic Turbulence of the 1970's

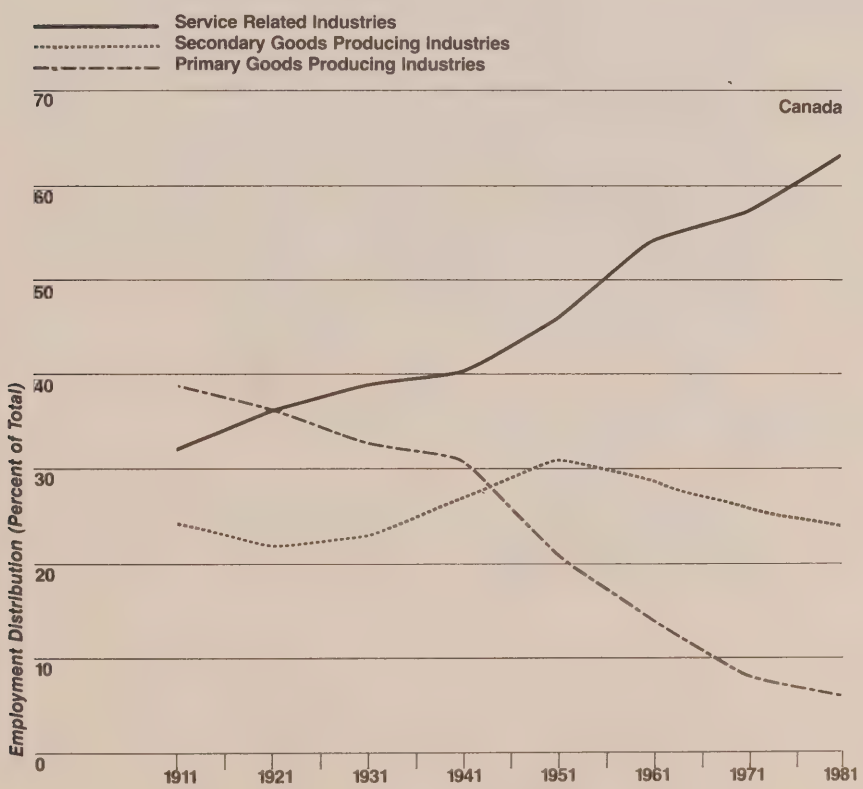
In comparison to well-established long-run trends of the past, the 1970's and onwards has been a period of great economic turbulence. The relationships between major economic variables have exhibited rapid relative movements, with magnitudes and directions of change not previously revealed by the long-run record. In particular, the record of slower output growth and slower employment creation make this period appear quite unusual.

Figure 2.1 shows a slowing rate of employment growth in the mid- to late 1970's, with subsequent absolute employment declines occurring during the recession of the early 1980's. Figure 2.2 reveals that output per employed person, or overall productivity, experienced little if any growth over the period from 1975 onwards, and that in real dollar terms average salary and wage expenditures have remained static or have declined since 1975.

There are conflicting interpretations regarding the factors which have caused the slowdown in the rate of growth of the economy and rising unemployment rates since the mid-1970's. Some suggest this is evidence of a different relationship between technological change and employment to that which has existed in the previous long-run historical record.

However, most are inclined to the view that the major economic events of the 1970's, not technological change, are the cause of this situation. Prices for oil increasing ten-fold almost overnight, huge rates of inflation, and interest rates at astronomic levels sustained by tight monetary policies, are believed to have conspired together to create an extraordinary situation which has adversely affected economic growth and the level of employment. Our view is that the evidence from this recent historical period is not robust enough to support the thesis that the employment effects of technological change have suddenly altered.

Figure 2.3 **Industrial Distribution of Employment, 1911 to 1981**



Source: *Historical Statistics of Canada*, 2nd Edition

2.2.6 Relative Importance of Demand Effects on Employment Growth

Recent studies have revealed the relative importance of economic demand over technological change as factors affecting employment growth in the overall economy.[12] [13]

One recent study[12] estimated what the employment profile, by industry, would have looked like in 1979 had Canada's output in that year been produced with 1971 technology and labour. The difference between the actual employment of 1979 and the estimated employment using 1971 methods of production reflects the changes in employment that arose, to a large extent, from technological adoption in the Canadian economy. Then, the impact of these changes was compared with the actual employment growth, by industry, to take account of changes to the industries in both the level and composition of final demand.

The conclusions are instructive. The study finds the influence of final demand in contributing to employment growth is far larger than the employment dislocations of changing production technology. Improved technology incorporated into the production processes affects the relative prices of goods and services, and, as a result, the composition and the level of demand, with the effect that employment growth occurred to a far greater extent than any apparent employment losses associated with the introduction of new technology.

This implies that technological change processes affect, and are affected by, changes in the level of final demand, and that the overall employment effects of technological change are indeed positive, as the long-run historical record shows.

Another recent study reaches similar conclusions by very different means.[13] In examining the reasons for persistently high unemployment rates in Canada, it was concluded these problems do not stem from unfavourable structural developments, but from a large shortfall of aggregate demand. The switch in macroeconomic management, from expansion in the 1960's, to gradual restriction in the 1970's, and to sharp contraction in the 1980's, is held to be responsible for most of the increase in unemployment in the last two decades, and the conclusion is that current unemployment is mainly due to demand deficiency.

2.2.7 Trends in Productivity Increases and Unemployment Rates

Another recent analysis,[14] which uses productivity increases as a proxy for technological change, suggests that rapid technological change does not occur during periods of high unemployment.

Figure 2.4 shows the historical record of productivity growth and unemployment rates. The data for productivity growth are in three-year moving averages to smooth out minor fluctuations.

The long-run historical record shows no period of simultaneous high unemployment and high productivity growth. While productivity measures can at best only suggest underlying movements of factors such as technological change, nevertheless the consistency of the long-run record is quite remarkable.

The data suggest that widespread capital investments embodying the application of new technology must await a favourable economic environment, and that periods of recession, high unemployment, or high interest rates, are not propitious for rapid rates of technological change. The record suggests that with high unemployment, wage levels are bid up less rapidly and it becomes more profitable to rehire than invest massively in risky new technology.

2.3 Labour Market Trends: 1950-1980

The demographic, social, and economic environments in which new technology is introduced and adopted will significantly affect, and be affected by, the processes of technological change.

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12 Magun, S. "The Effects of Technological Changes in the Labour Market in Canada." Canadian Economics Association Meeting, Guelph, May, 1984.

13 Fortin, P. "Unemployment in Canada: A Macroeconomic Disease Looking for a Macroeconomic Cure." Conference on Unemployment. Centre for Industrial Relations, University of Toronto, Toronto, November, 1984.

14 Dungan, P. Appendix 20.

In this section we review important labour market trends that have occurred in Ontario during the post-war period (for details see Appendix 1). We do so in order to establish important contextual factors which may affect, and be affected by, continuing processes of technological change into the next decade.

We proceed in the following order:

- First, we describe important demographic trends underlying Ontario's labour market;
- Second, we review the educational background of the labour force;
- Third, we describe broad trends in industry and occupational employment which have occurred during the post-war period (we shall analyze recent occupational employment trends in detail in Section 2.4);
- Fourth, we review trends in the organization of work-tasks, including part-time work, and hours-worked; and
- Finally, we review data pertinent to unemployment and job vacancies.

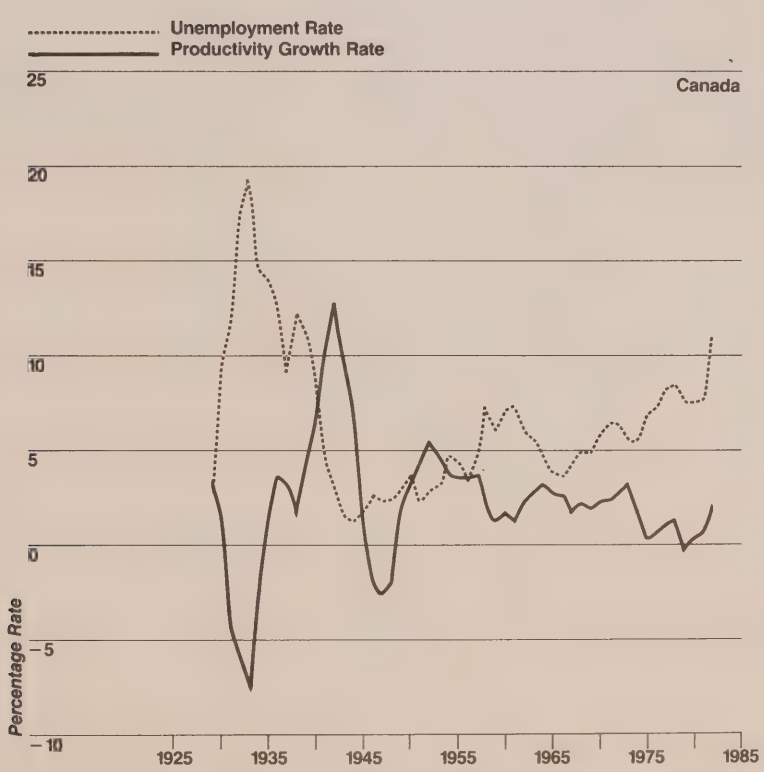
2.3.1 Ontario's Aging Population

Ontario's population has increased in size each year during the post-war period. The most rapid period of growth occurred in the 1950's, but since that time the trend has been toward a diminishing rate of growth. Fertility rates and immigration have been the most significant factors which have affected rates of population growth.

In the 1960's the fertility rate started to decline, and is presently far below the level necessary to replace the population on a long-term basis. However, the baby-boom which occurred in the 1950's has had, and will continue to have, very significant effects on Ontario's labour force.

Since Ontario has traditionally received approximately one-half of the immigrants admitted to Canada, this source of population growth is closely tied to national immigration policy. Numbers of immigrants admitted to Ontario have varied widely from year to year; for example, from 39,000 persons in 1950 to 104,000 in 1951 as large numbers of displaced persons from Europe were accommodated. Since that time, immigration levels remained relatively high, but have declined somewhat after 1976 as a result of further changes to immigration policy.

Figure 2.4 **Productivity Growth Rates and Unemployment Rates, 1925 to 1982**



Source: *Historical Statistics of Canada*, 2nd Edition and Appendix 20

Figure 2.5 shows the population of Ontario, by age cohorts. The movement of the baby-boom through the years can clearly be seen, with the 0-14 age group reaching its largest size in the late 1960's, the 15-24 age group peaking in size in the late 1970's, and the 25-44 age group still on the increase in the 1980's. The result of the decline in fertility rates is the beginning of a decline in the proportion of young persons aged 0-24 in the population, and an increase in the proportion of persons aged 25 and older. Thus the early 1980's showed the beginning of a trend toward a gradually aging population.

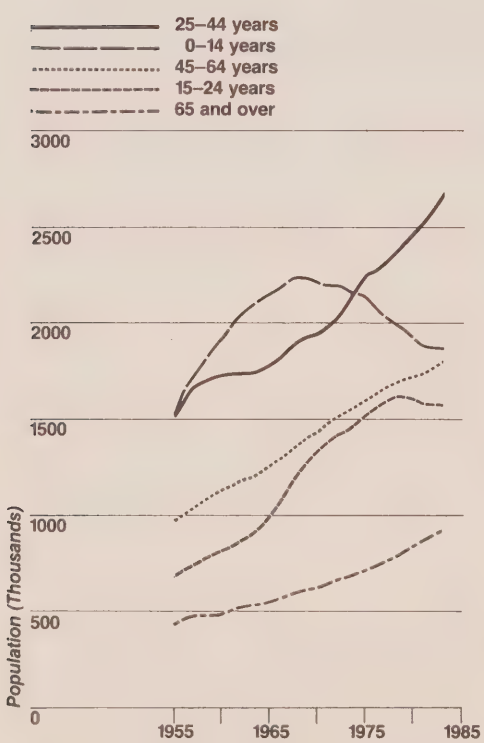
This trend will be a fundamental force causing future changes in many institutions and sectors of Ontario's society. As we look ahead to the consideration of the 1985-1995 period, we should recognize the powerful effect the aging population will have. The changing age-profile of the population will cause changing patterns of demand for goods and services; for example, an aging population doesn't eat as much food per capita, neither will it likely need as many educational services delivered in traditional ways. But, as the composition of the population changes, so will opportunities and needs develop for new technology; for example, in regard to home-delivery of services for the aged, as an alternative to institutionalization. Many such opportunities will arise for service-related industries, and many of those in the publicly-administered sector.

2.3.2 Participation of Females in Ontario's Labour Force

By 1983, Ontario's labour force, including those employed and those unemployed but actively looking for work, had grown to over 4.5 million persons.

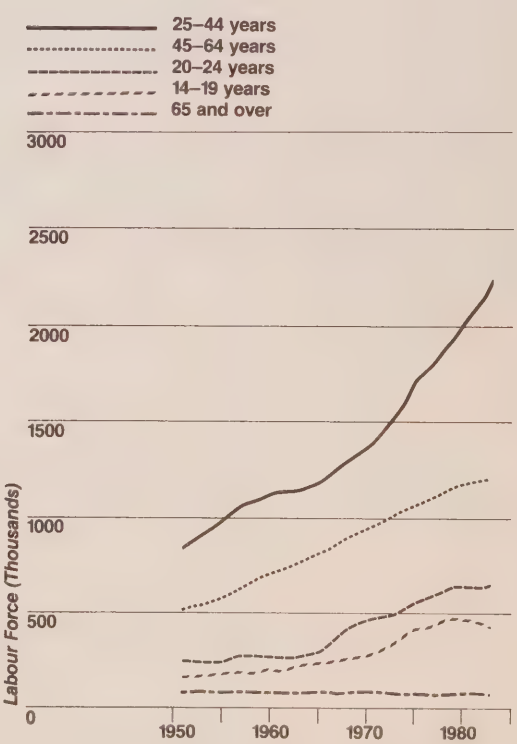
Figure 2.6 shows the growth of the labour force, by age cohort, over time. The most important driving factors are the entry of the baby-boomers into the labour force, and the changing participation rates of females of all ages. The figure shows the increasing numbers of youth in the labour force, and how the share of the 20-24 age group has increased. The fact that the share of youth did not increase more dramatically was due largely to increasing school enrollment, an increase in the compulsory school leaving age to 15, and the prolongation of youth education and training.

Figure 2.5 **Population by Age in Ontario, 1955 to 1983**



Source: Statistics Canada, 91-202 and Appendix 1

Figure 2.6 **Labour Force by Age in Ontario, 1951 to 1983**



Source: *Statistics Canada, 71-529, Ontario Statistics 1982* and Appendix 1

The most dramatic trend affecting the growth and composition of Ontario's labour force in the post-war period has been the participation of females.

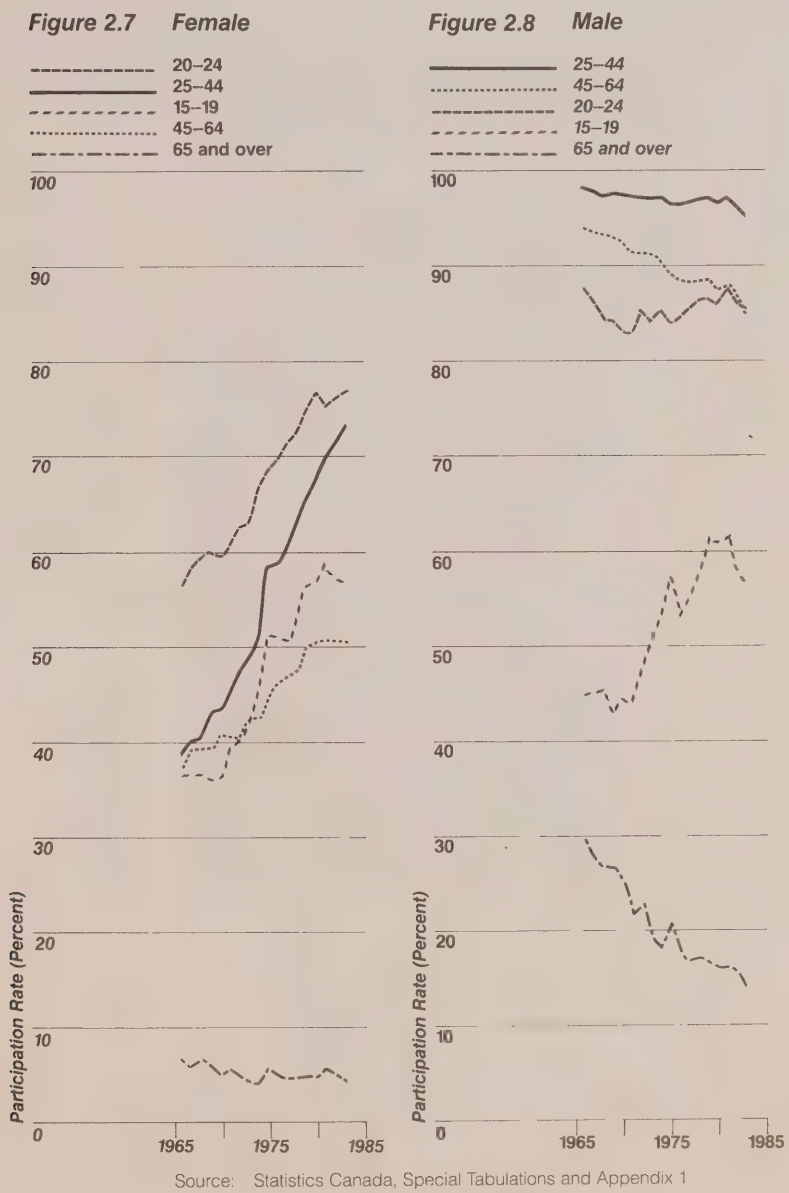
Women increased their share of the labour force to over 40 percent by 1983. The change in composition of the labour force has been due to steadily increasing participation rates by females of all ages, particularly those between 25 and 44. The trend is toward increasing participation by females in all age categories, as shown in Figures 2.7 and 2.8. The result has been a dramatic shift in the composition of the labour force as revealed in Figure 2.9. Ontario's labour force has increasing participation rates by females, increasing numbers of employed females, and an increasing share of total employment occupied by females.

Looking to the future, it is a matter of debate whether the participation rates for females will continue to rise. What is clear is that there are large and growing numbers of females in the workforce, and that they will increasingly expect equitable access to all types and levels of occupations.

2.3.3 Educational Attainments of the Labour Force

The level of formal education of Ontarians has risen significantly over the post-war period. In 1960, close to 80 percent of the population had not completed a high school education; by 1981, this proportion had been reduced to 50 percent. Similarly, the proportion of the population having educational attainments at the

Labour-Force Participation Rates by Age in Ontario, 1966 to 1983

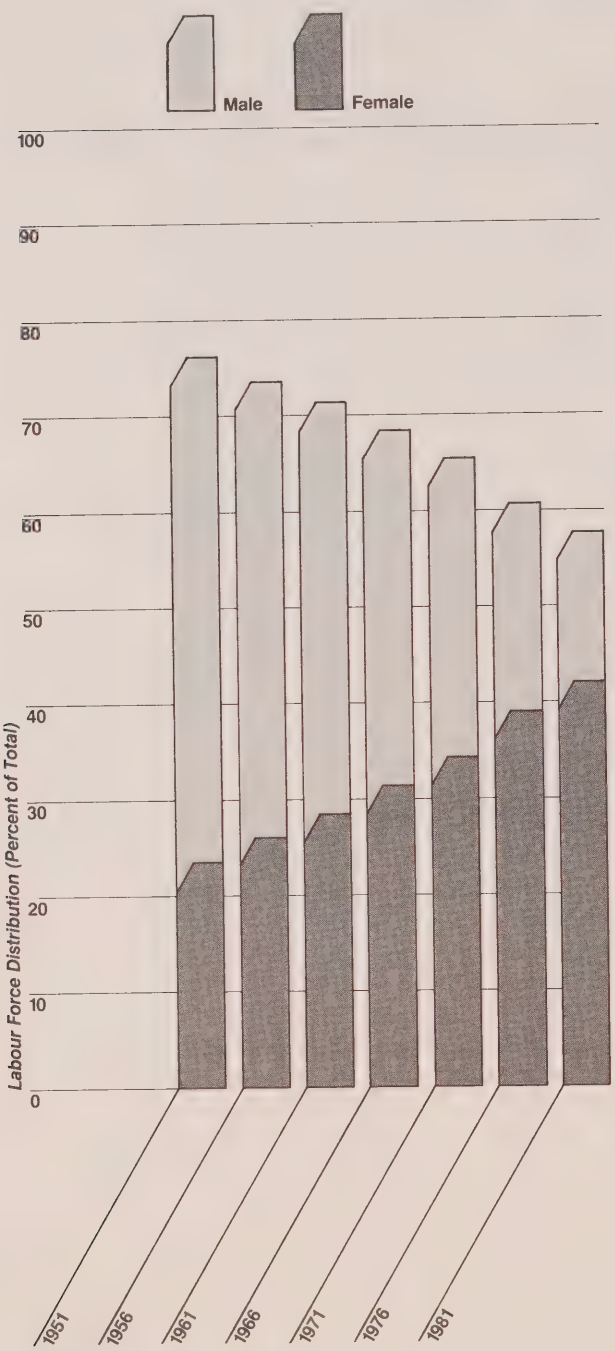


Source: Statistics Canada, Special Tabulations and Appendix 1

post-secondary level has increased dramatically; by 1981, over 40 percent of the population had some post-secondary education, as compared to only 7 percent just two decades earlier.

During the latter part of the 1960's the baby-boom generation entered the post-secondary system in unprecendented numbers. Post-secondary enrollments have continued to rise since that time, with female enrollments rising at a faster rate than males. During the same period, particularly during the latter part of the 1970's, increasing pressure was felt on the capacity of professional post-secondary programs, especially schools of business, management, and engineering, as demand for their programs grew; in large measure, the demand resulted from females choosing to pursue professional programs in unprecedented numbers.

Figure 2.9 **Percentage Distribution of the Labour Force by Sex in Ontario, 1951 to 1981**



NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada 74-529, *Ontario Statistics 1982* and Appendix 1.

As shown in Figure 2.10, the average levels of education of different age cohorts of Ontario's population are highly skewed, reflecting our history of immigration and tremendous public investments in educational activities during the post-war period. Not surprisingly, the younger age-group cohorts of the present population have much higher levels of formal educational attainment than the older groups. Thus, as the population of Ontario ages, and retiring older workers are replaced by younger workers with higher levels of formal educational attainment, the overall level of education of the labour force will continue to increase.

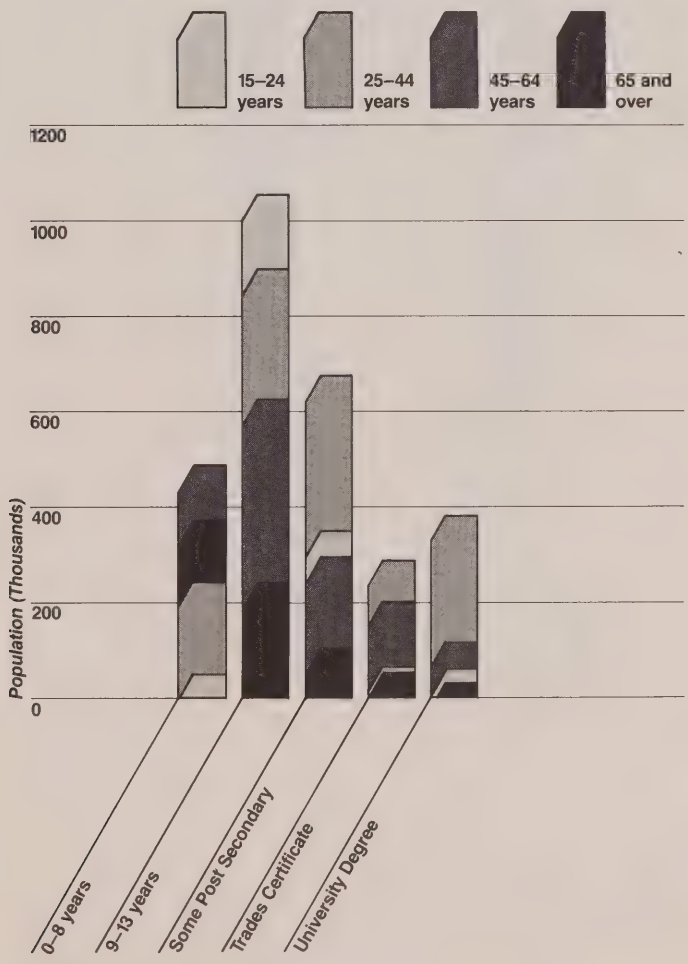
2.3.4 Employment Share by Industry-Sector

During the post-war period, the industrial composition of Ontario's employed labour force has altered dramatically.

Earlier, in Figure 2.3, we reviewed the long-term industrial patterns of employment that have evolved during this century for Canada. Those for Ontario have followed similar trends.

Since the Second World-War there has been substantial growth in the portion of the labour force employed in Ontario's service-related industries, and a relative decline in the portion employed in goods-producing industries, as shown in Figures 2.11 and 2.12. (In these figures, primary goods-producing industries include: Agriculture; Fishing; Forestry; and Mining. Secondary goods-producing industries include: Manufacturing; Construction; and Utilities. Service-related industries include: Transportation and Communication; Trade; Finance; Community, Business and Personal Services; and Public Administration.) Although employment in the secondary goods-producing sector has grown in absolute numbers over the post-war

Figure 2.10 **Highest Level of Schooling for Population 15 years and over by Age Groups in Ontario, 1981**



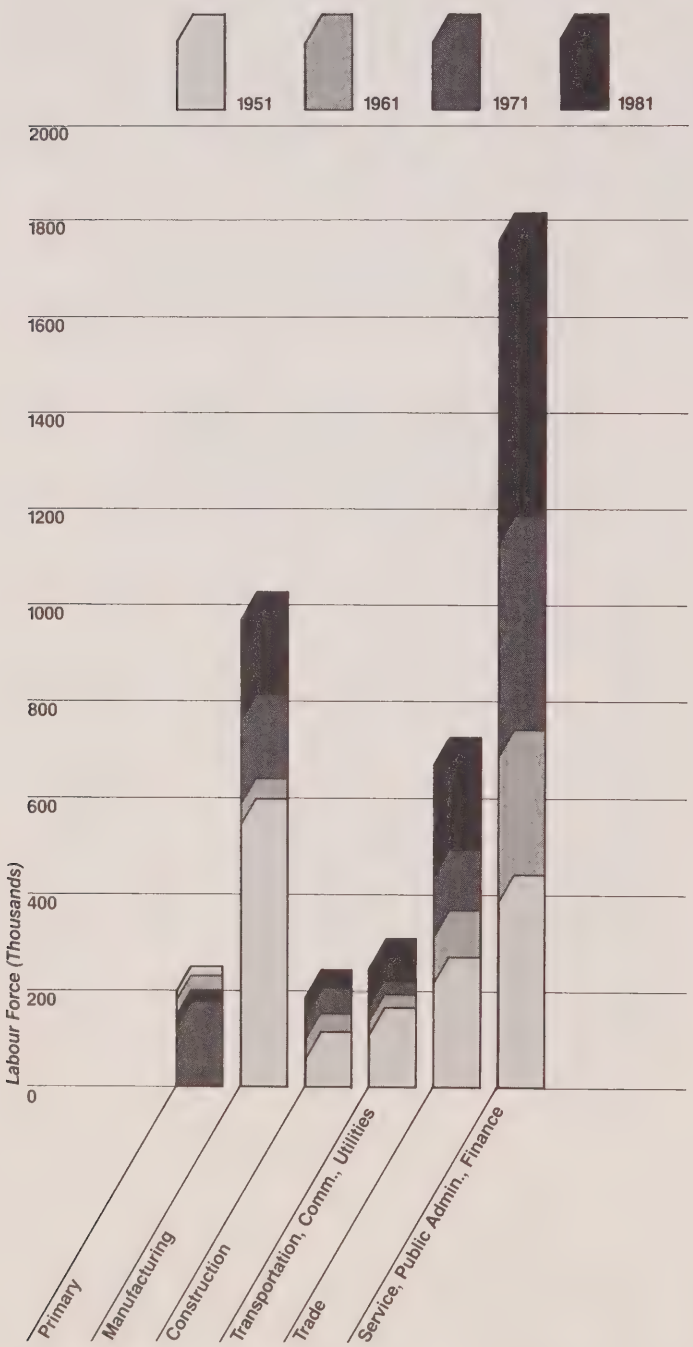
NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, 92-914 and Appendix 1

period, the share of the total labour force directly involved in the production of physical goods has declined since the early 1950's. In 1951, about 14 percent of Ontario's labour force was employed in the primary goods-producing and extractive industries, and some 38 percent was in the secondary goods-producing industries. By comparison, in 1981, primary goods-producing industries accounted for only 3.5 percent of the labour force, and secondary-manufacturing had declined to 28 percent.

The influence of technological change in the primary industries, and the resulting huge increases in output per employed person are well known; the changes in Agriculture are particulary noteworthy.

In regard to apparent declines of the total employment share directly connected

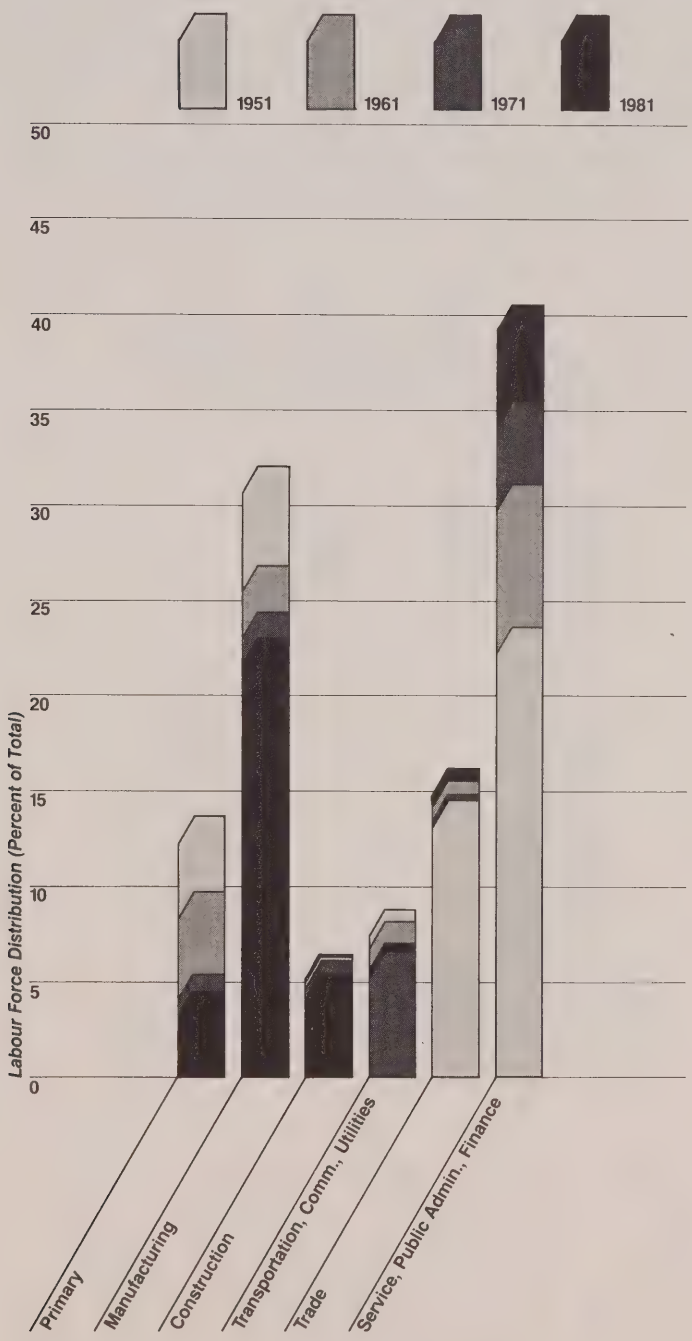
Figure 2.11 **Labour Force by Industry Group in Ontario, 1951 to 1981**



NOTE Bars are one behind another with the smallest at the front
Source: Statistics Canada, *1961 Census*, Statistics Canada, 92-925 and Appendix 1

with secondary goods-production, it is our feeling that in part this is a reflection of work-tasks being redistributed across industries. In the face of competition, there has been a growing tendency for modern, efficiently run manufacturing organizations to reduce their overhead costs as much as possible. One way to achieve this is by purchasing services from outside organizations as necessary, rather than by continually carrying the overhead of providing an internal functional capability. Thus, for example, certain research and development services, engineering design services, management services, computer services, accounting services, advertising and sales services, may now be provided to secondary goods-producing industries more efficiently by specialty firms than from within their own organizations. In consequence, employment which was previously accounted for within manufac-

Figure 2.12 **Percentage Distribution of the Labour Force by Industry Group in Ontario, 1951 to 1981**

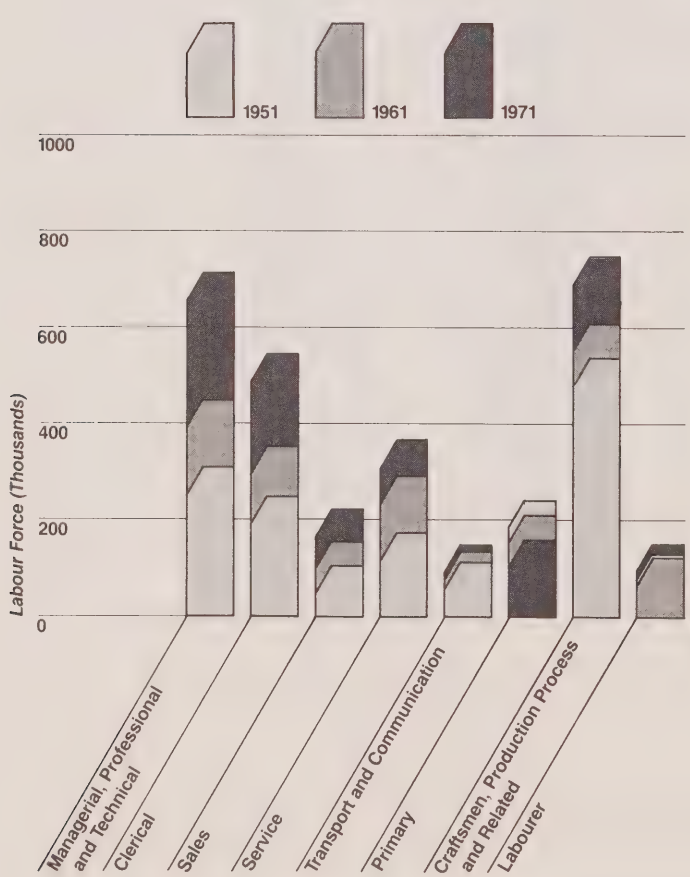


NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, *1961 Census*, Statistics Canada, 92-925 and Appendix 1

turing industries may now have moved to service industries. This sort of industrial movement of work-tasks is of course part of the technological change process, and could not be accomplished without other services, for example in telecommunications. Attention is drawn to the matter here in order to avoid the erroneous impression that the declining proportion of direct employment in goods-producing industries implies a declining importance of these industries to employment overall. Nothing could be further from the truth, and it needs to be clearly understood that high employment levels in all industries, including service-related industries, depend to a large degree upon healthy economic performance of our goods-producing industries.

The share of overall employment associated with service-related industries has increased from 47 percent in 1951 to 62 percent in 1981. In addition to those factors noted above, rising proportionate employment in service-related industries can be explained by other influences. The population growth in the 1950's created a strong demand for increased health, education, and other publicly-funded services. With the high rate of post-war economic growth, and increased tax revenues available to governments, spending on health, education and social services could respond to increased public demands. In addition, rising real incomes encouraged rising demand for an increasing range of trade, financial and personal services. As a consequence, the combined effects provided substantial demands for rapid growth in service-related industries.

Figure 2.13 **Labour Force by Occupational Group in Ontario, 1951 to 1971**



NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, 94-716 and Appendix 1

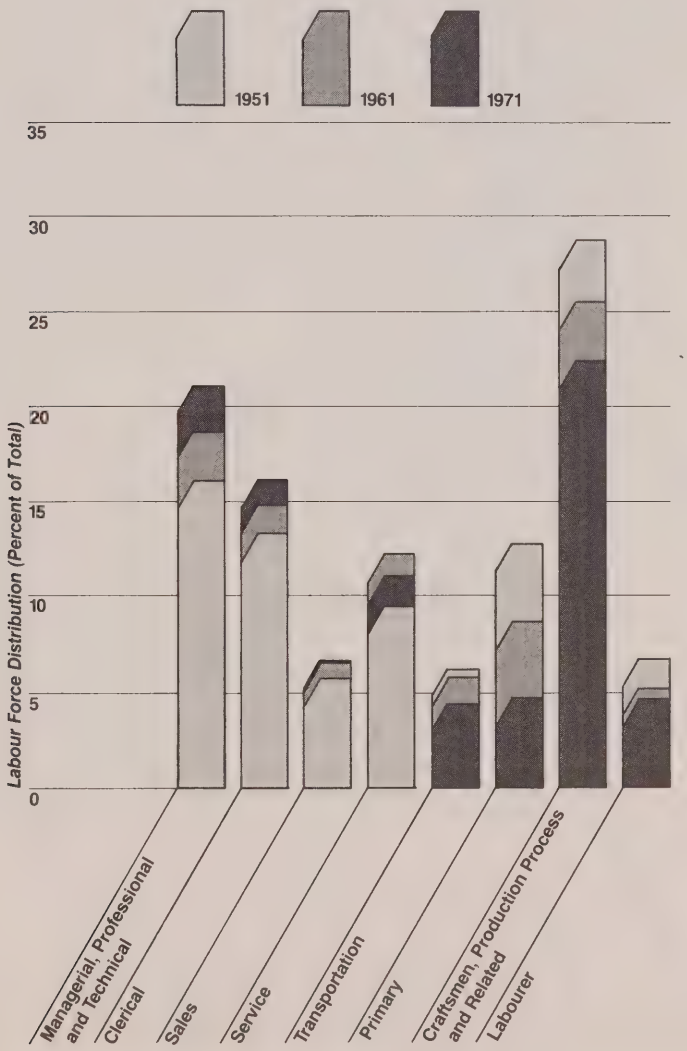
2.3.5 Employment Trends by Occupational Group

Accompanying the movement of employment toward service-related industries has been a proportionate shift in employment from production-related occupations to white-collar occupations.

Since occupational changes reflect the changing patterns of work-tasks accompanying technological change, we shall later examine this movement in more detail. Here, with an aggregated level of occupational data, we note that over the post-war period the largest labour force growth has occurred in the managerial, professional, and technical occupations, followed by clerical, and service occupations. Figures 2.13 and 2.14 show that in 1951 these occupations made up about 50 percent of Ontario's labour force; by 1981, they accounted for close to two-thirds of overall employment.

We shall also later examine the relative concentration of males and females by occupation. Here, we note in particular the rising proportion of females in the managerial, professional, and technical occupations, and the continued high concentration of females in clerical occupations, particularly in service-related industries. This also is a subject to which we shall later return as we probe the likely future impacts of technological change.

Figure 2.14 **Percentage Distribution of Labour Force by Occupation Group in Ontario, 1951, 1961 and 1971**



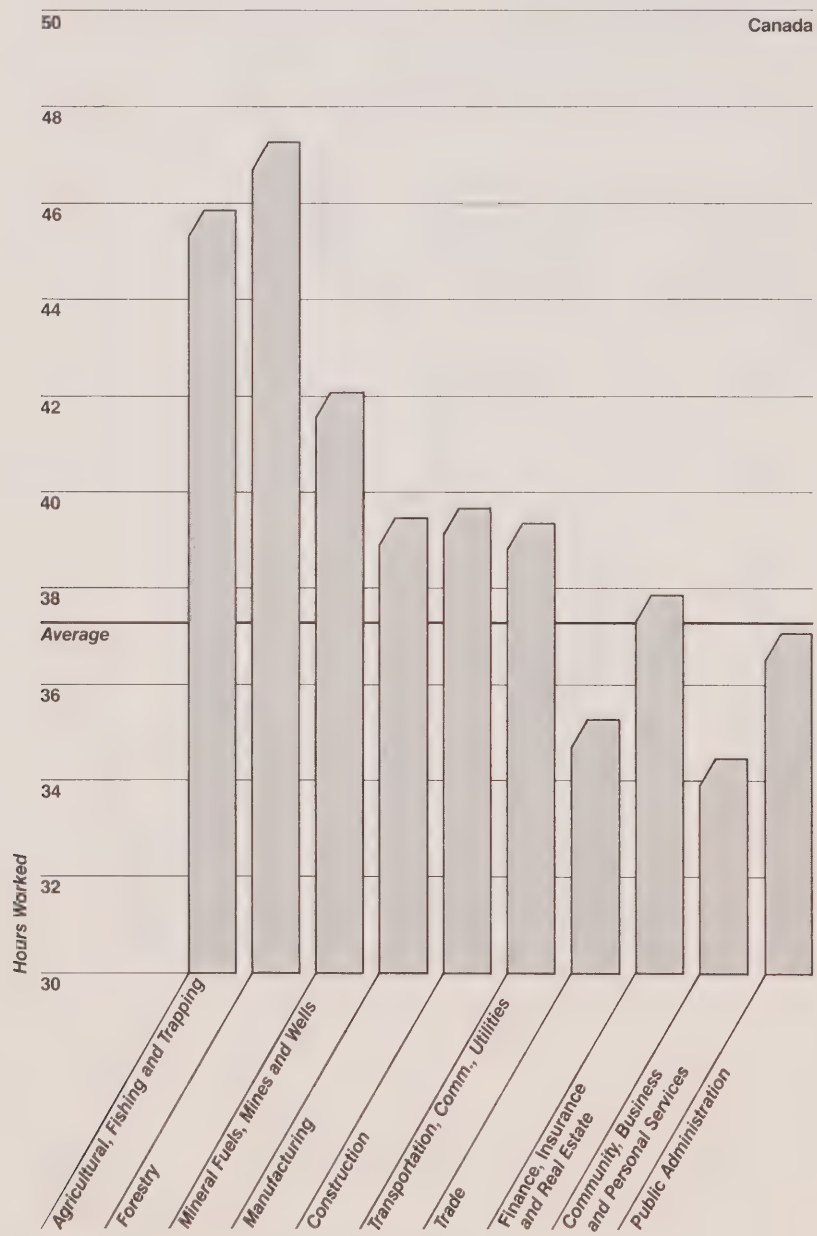
NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, 94-716 and Appendix 1

2.3.6 Number of Hours Worked

Data which reliably describe trends in the number of hours worked are scarce. The data which are available suggest that the declining trend which occurred before the Second World-War has leveled off. When data of usual hours worked are viewed on an industry basis, significant differences between industries emerge, as shown in Figure 2.15.

It should be noted that the changing patterns of industrial employment, with an increasing share of overall employment in service-related industries, would cause a lowering of the work week for the whole population, since the industry norms of hours worked in service-related industries are lower than for other industries. That is, without work practices changing on an industry-specific basis, the average of usual hours worked across the total employed population would be expected to show a declining trend with time simply because of trends toward employment in service-related industries.

Figure 2.15 **Usual Hours Worked by Industry Group (Main Job), 1983**

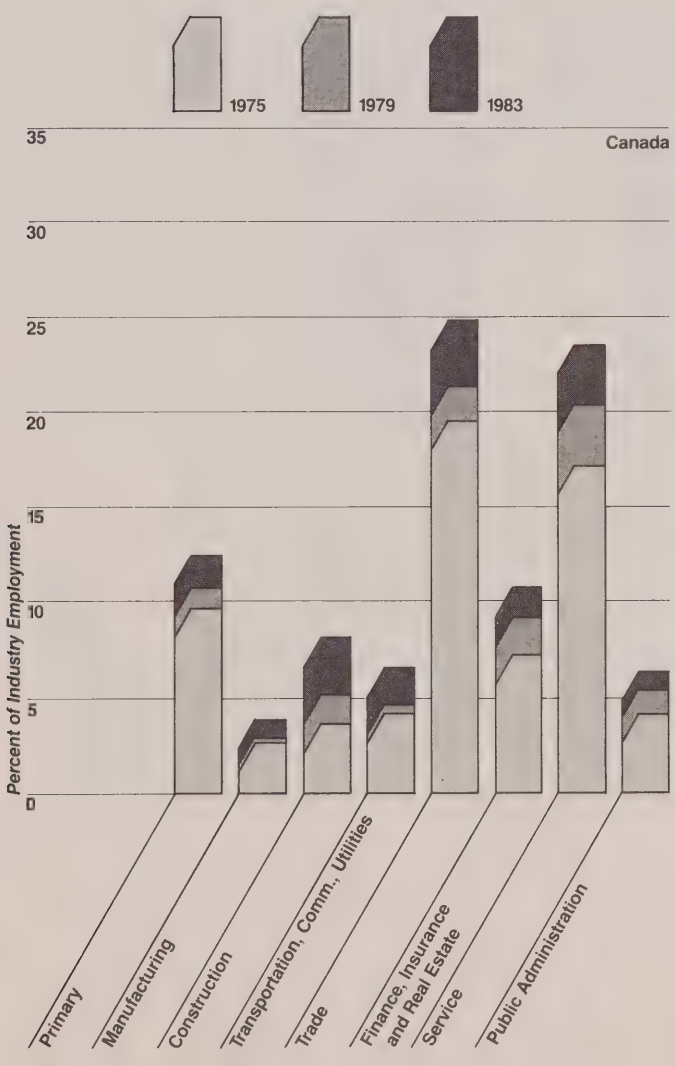


Source: Statistics Canada, 71-529 and Appendix 1

2.3.7 Part-Time Employment

Statistics for Canada show the extent of part-time employment has grown. Approximately 16 percent of all employees worked on a part-time basis in 1983. Figure 2.16 shows the percentage of part-time work within each industry-sector, revealing the Retail and Wholesale Trade sector as having the largest proportion of their employees as part-time. The Trade sector, together with the Service sector, shows the greatest increase of part-time employment over time, while the Manufacturing sector, which has the smallest proportion of part-time workers, shows little increase over the period 1975-1983.

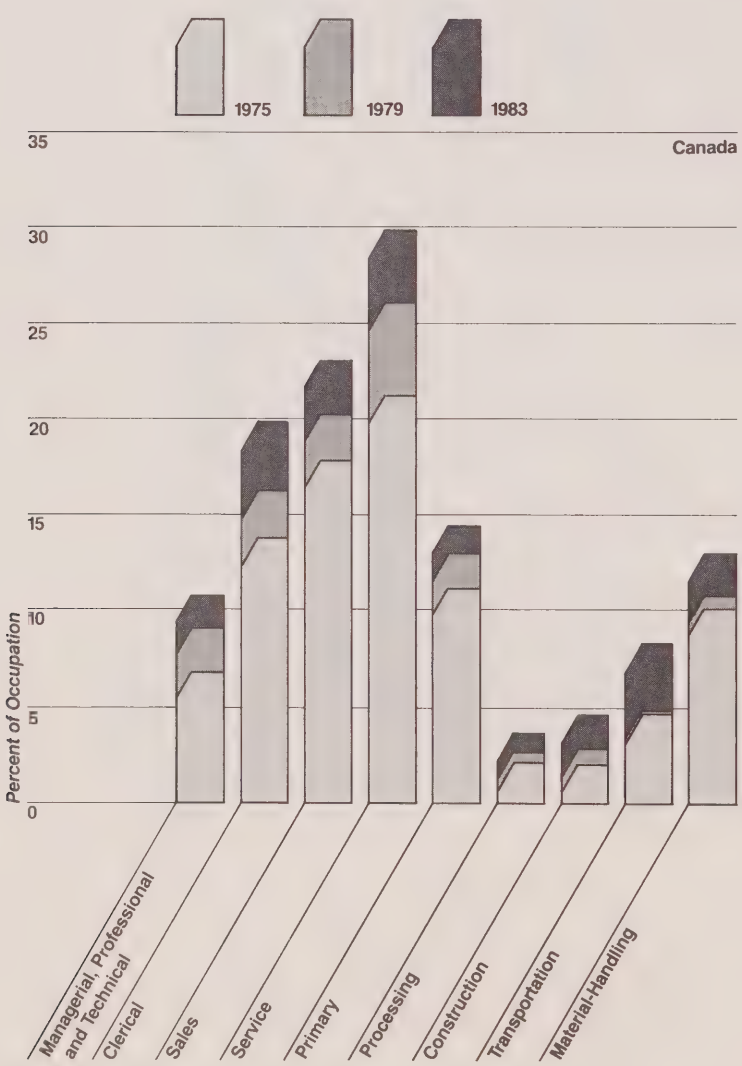
Figure 2.16 **Part-Time Employment by Industry Group, 1975, 1979 and 1983**



NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, 71-529, and Appendix 1.

Part-time employment also shows considerable variation between occupational groups. Service, Sales, and Clerical occupations had the largest proportion of part-time workers in 1983. Figure 2.17 shows that part-time employment has grown among all occupational groups, while Service occupations showed the fastest rate of growth between 1975 and 1983. (We restrict ourselves to the 1975 onward time period since the definition of part-time employment was altered by Statistics Canada at that time. Up to 1975, part-time employment was defined so as to include persons working up to 35 hours per week; after 1975, part-time employment consists of those who usually work less then 30 hours).

Figure 2.17 **Part-Time Employment by Occupational Group, 1975, 1979 and 1983**

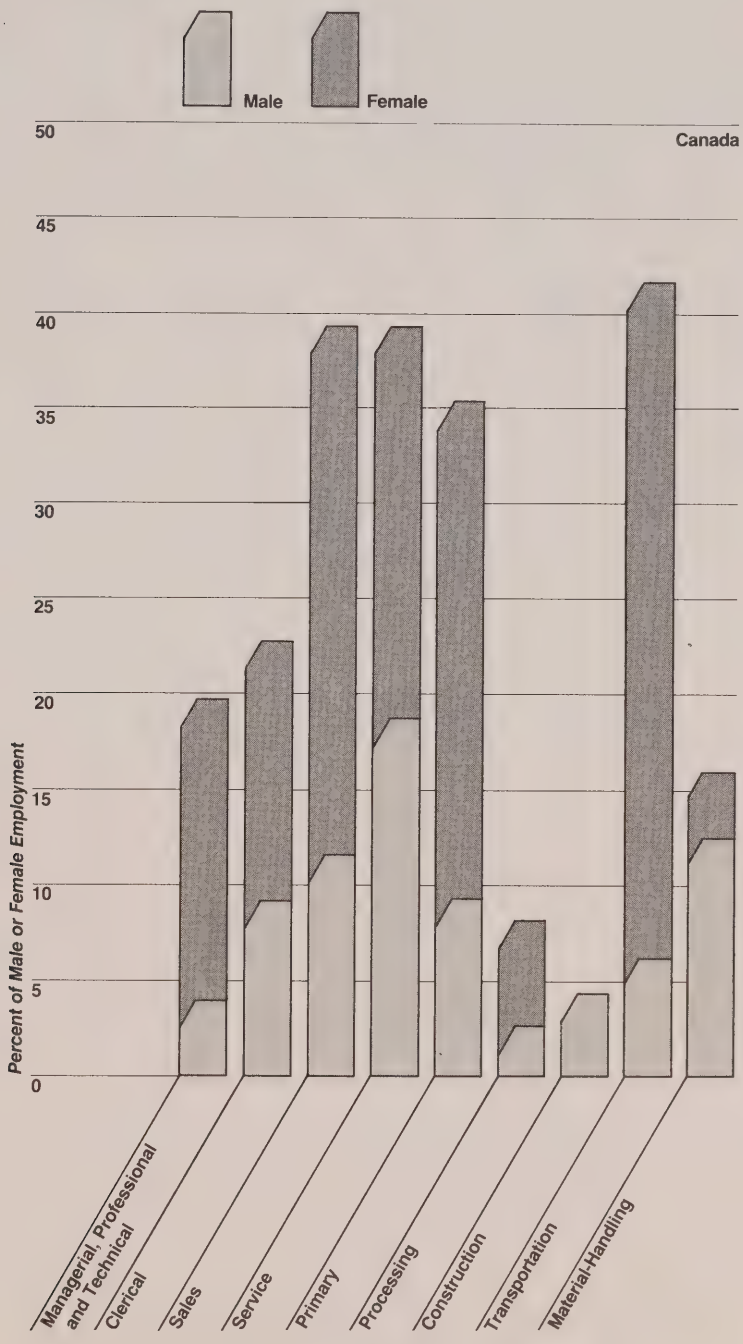


NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, 71-527 and Appendix 1.

We also note from Figure 2.18 that proportionately more females than males are employed part-time in all occupations. In 1983, about 71 percent of all part-time workers in Ontario were females, and the proportion of jobs held by women that are part-time has been increasing since 1975.

The extent of part-time work is a subject we shall address later when we turn our attention to likely future employment patterns.

Figure 2.18 **Part-Time Employment by Sex and Occupation, 1983**



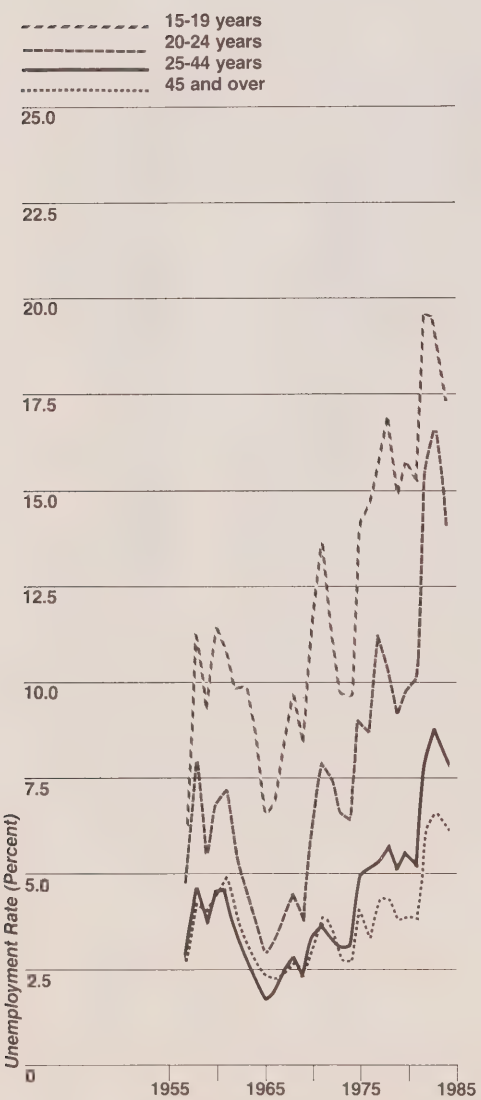
NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, 71-527 and Appendix 1

2.3.8 Unemployment Rates and Job Vacancies

Between 1950 and the early 1970's, unemployment rates in Ontario fluctuated between 2 percent and a high of 6 percent. Following the oil-shocks of the early 1970's, unemployment rates in Ontario snaked upwards to reach the region of 11 percent during the recession of the early 1980's. Recently, the rates have declined and were close to 8 percent in early 1985.

The burden of unemployment has disproportionately been experienced by younger age groups, by those with poorer educational attainments, and by those in certain industries. These trends are shown in Figures 2.19, 2.20, and 2.21. In particular, youth unemployment rates have consistently been higher than those for older age groups, and since the mid-1970's the unemployment rates for the 15-19 and 20-24 age groups have increased faster than those for older workers. This was due to the slowdown in economic growth of the 1970's, the associated slowdown in the growth of new jobs, and the consequent inability of the economy to absorb large numbers of new labour force entrants with little or no work experience.

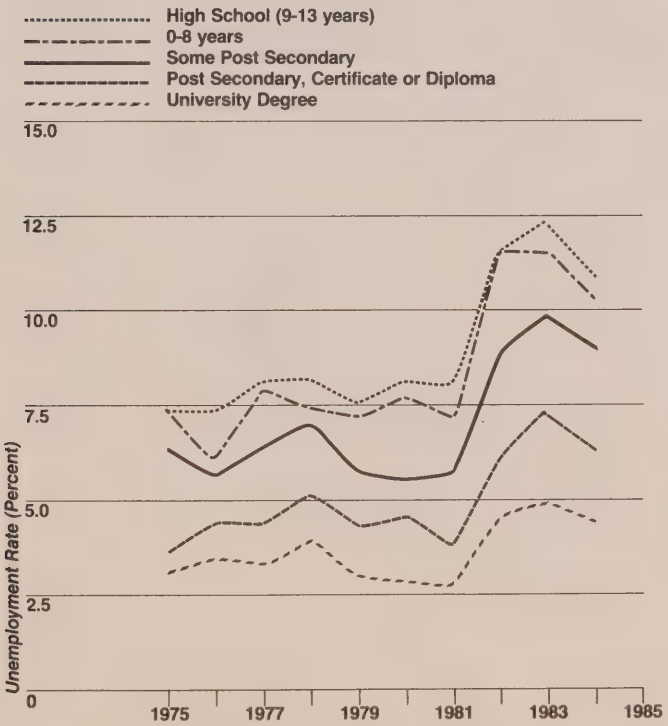
Figure 2.19 **Unemployment Rates by Age Group in Ontario 1957 to 1984**



Source: Statistics Canada, 71-529, *Ontario Statistics 1982* and Appendix 1

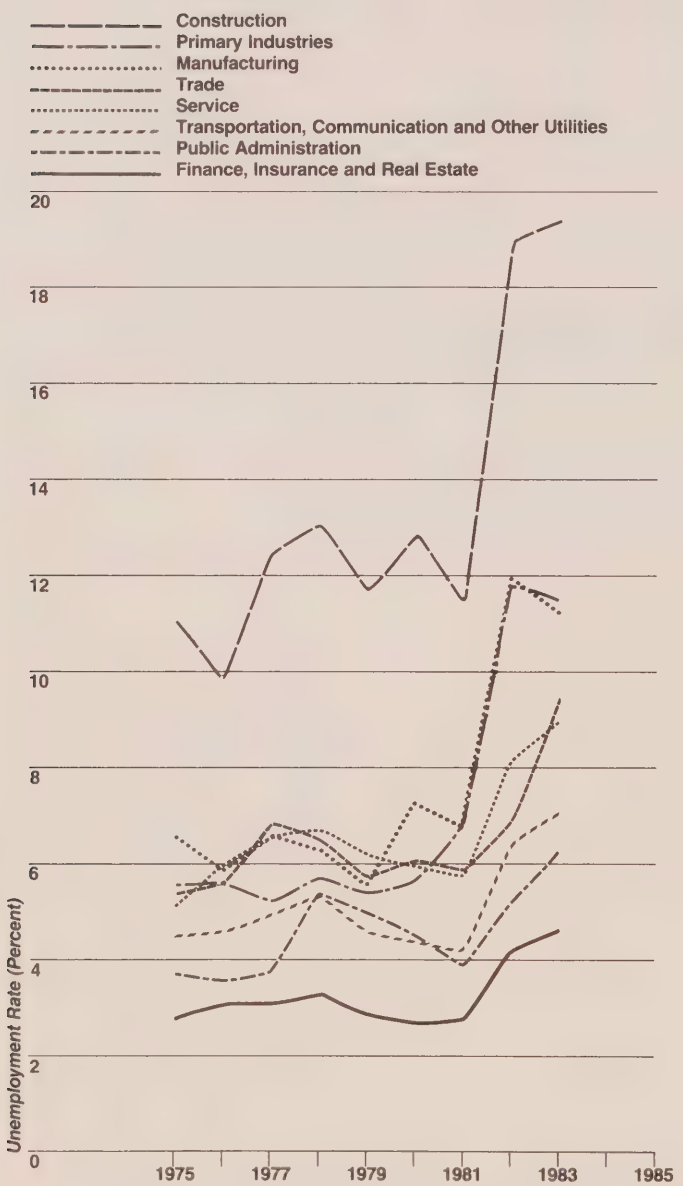
Some observers have attempted to correlate unemployment rates with job vacancy rates, and to suggest the simultaneous occurrence of rising unemployment rates with apparently rising job vacancy rates means there exists a skill-mismatching in the labour market. The conclusion has been drawn by some observers that those who are currently unemployed have the wrong skills with respect to the demands of the job market, and that were they to be trained with different skills they would not be unemployed.

Figure 2.20 **Unemployment Rates by Educational Attainment in Ontario, 1975 to 1984**



Source: Statistics Canada, 71-529 and Appendix 1

Figure 2.21 **Unemployment Rates by Industry Group in Ontario, 1975 to 1983**



Source: Statistics Canada, Special Tabulation and Appendix 1

While accepting this as being true for some specialized occupational groups of limited size, the quality of data available does not appear robust enough to demonstrate the validity of this thesis on an overall basis. Job vacancy data were collected by Statistics Canada until 1978. The aggregated results are shown in Figure 2.22. These data simply suggest a lack of jobs for those unemployed. In the absence of job vacancy data being collected after 1978, some analysts have turned their attention to measures such as the Help Wanted Index, a measure of the extent of newspaper advertising devoted to job vacancies. The meaning of data collected by such analyses appears open to question, and we are uncomfortable with conclusions which suggest that a substantial factor in the current unemployment problem is that the unemployed have the wrong skills. While this may be a factor for certain occupations, we are persuaded that the overall current situation is more appropriately described as being one in which the relative absence of job vacancies is the major contributor to the problem.

However, in saying this we do not wish to be misunderstood. As we have already argued, changes in occupational employment are intimately connected with technological change. And, as we shall later report, skills-training and the matching of the skills of the labour force to future patterns of occupational demand are central to the question of future technological and employment-related changes. What we state here is our view that the magnitude of the current unemployment problem cannot be explained to any substantial degree by jobs remaining vacant because of unskilled applicants. Indeed, consistent with our earlier observations regarding the relative importance of demand effects on employment growth, our sense is that the current unemployment problem is much more associated with insufficient demand levels in the economy than to do with skills of the labour force.

Figure 2.22 **Unemployment Rates and Job Vacancy Rates, 1951 to 1978**

Source: *Historical Statistics of Canada*, 2nd Edition

2.4 Industry-Sector and Occupational Employment Trends: 1971-1981

We now review data which describe industry-sector and occupational employment trends that have developed in Ontario over the 1971-1981 period. As we noted earlier, over the longer term the changing nature of work-tasks associated with technological change will result in measurable occupational trends. These trends will be industry-specific and will reflect the changing nature of that industry's technology. Consequently, the subject of occupational change is of central importance in any review of the employment-related effects of technological change. At an industry-sector level it is practical to present data which completely describe trends encompassing all Ontario.

In this section we proceed as follows:

- First, for each of 23 industry-sectors we review: employment levels, employment growth, employment growth rates, and market share of overall employment. We pay particular attention to the differing patterns for males and females.
- Second, on an overall basis across all industry-sectors, for each of 23 major occupational groups we review: employment levels, employment growth, employment growth rates, and market share of overall employment. Again, we pay particular attention to the differing patterns for males and females.

The data are for total employment, and were obtained from the 1971 and 1981 Statistics Canada census. (A detailed analysis of this data is presented in Appendix 2.)

2.4.1 Industry-Sector Trends, 1971-1981

Employment Levels and Distribution

In 1981, 1,376,000 persons were employed in goods-producing industry-sectors in Ontario, and 2,797,000 persons in service-producing sectors. As shown in Figures 2.23 and 2.24, from among a total of 23 industry-sectors, the four largest employers are service-related industry-sectors which together contain 57 percent of overall employment. The Community, Business and Personal Services sector alone accounted for 28 percent of overall employment in 1981; followed by the Wholesale and Retail Trade sector (16 percent); Public Administration (7 percent); and Finance, Insurance and Real Estate sector (6 percent).

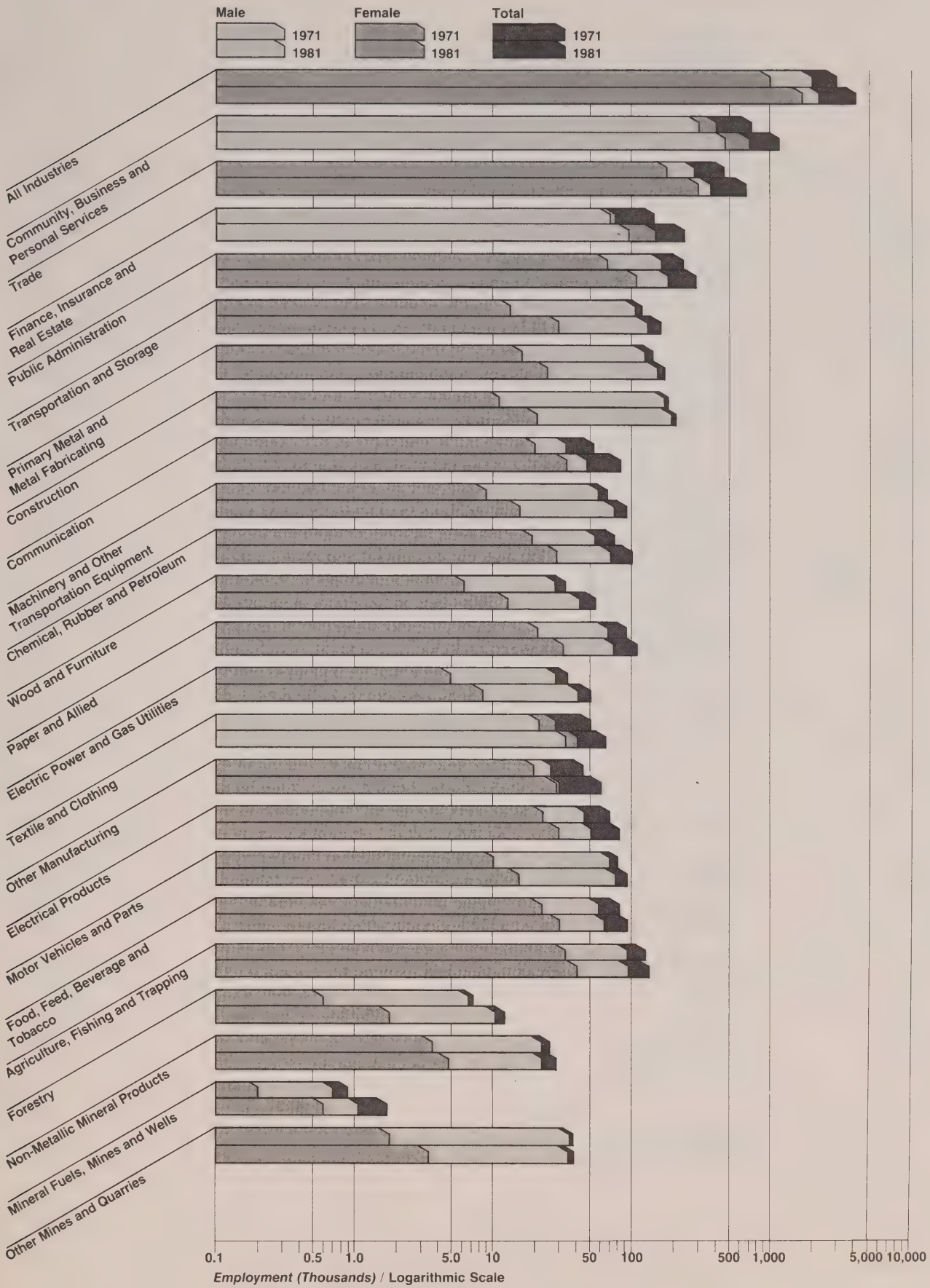
Employment Growth and New Job Creation

Employment in Ontario increased from 3,165,000 persons in 1971 to over 4,174,000 in 1981, or, on average, by about 100,000 new jobs per year.

Figure 2.25 and Table 2.2 show that over 70 percent of all additional new jobs were created in three industry-sectors: Community, Business and Personal Services; Trade; and Finance, Insurance, and Real Estate.

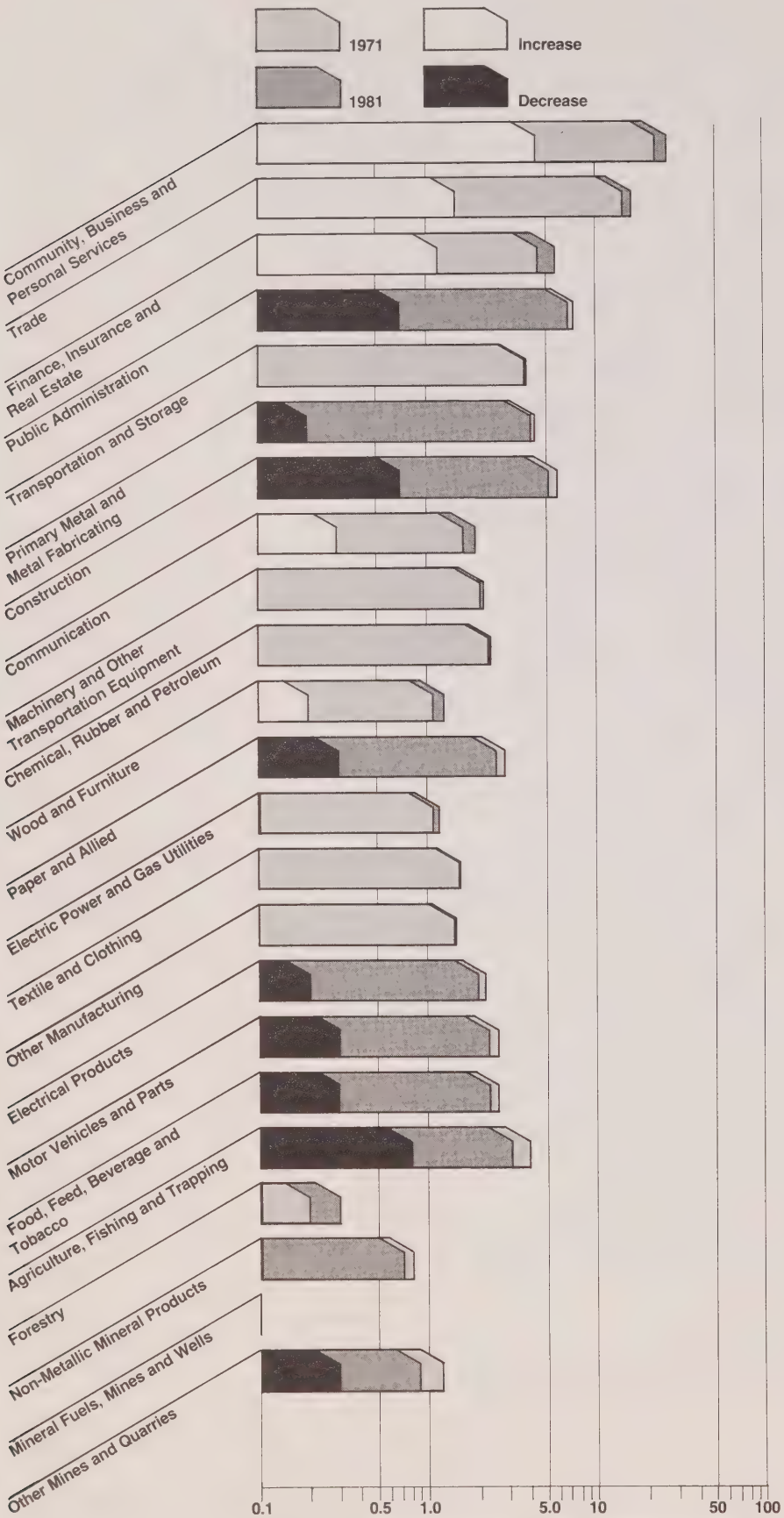
All industry-sectors created some additional jobs, and no industry-sector showed an absolute decline in employment over 1971-1981.

Figure 2.23 **Employment by Industry-Sector and Sex in Ontario, 1971 and 1981**



NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

Figure 2.24 **Distribution of Employment by Industry-Sector in Ontario, 1971 and 1981**



NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

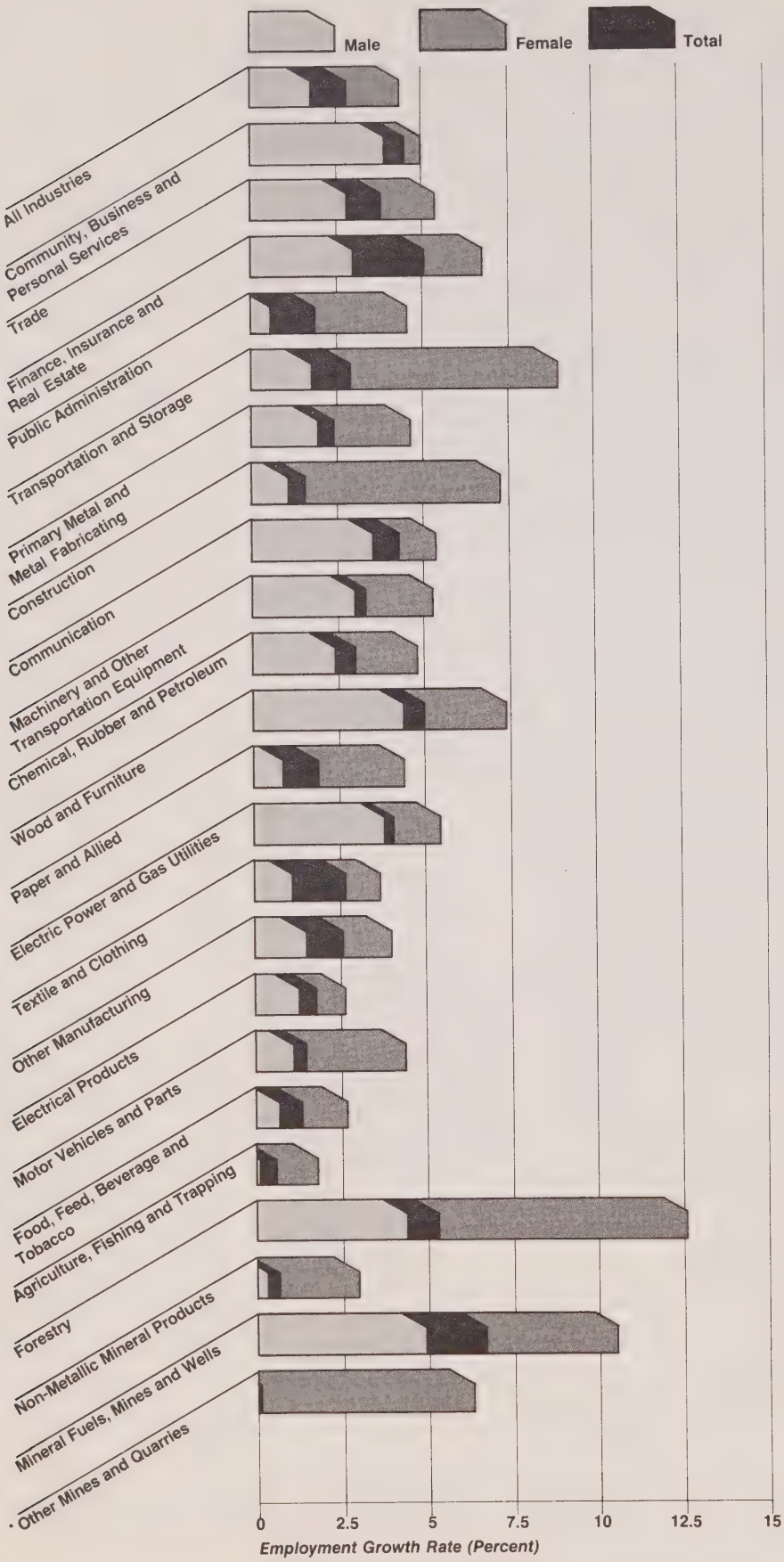
Figure 2.25 **Employment Growth by Industry-Sector and Sex in Ontario, 1971 to 1981**

NOTE Bars are one behind another with the smallest at the front.

*Male: —1.1

Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

Figure 2.26 **Employment Growth Rates by Industry-Sector and Sex in Ontario, 1971 to 1981**



NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

*Male: —0.3

Employment Growth Rates and Labour Market Share

Over the 1971-1981 period, overall employment in Ontario grew at an annual compound rate of 2.8 percent.

Industry-sectors which grew faster than the average for Ontario increased their market share of overall employment. Figure 2.26 and Table 2.2 show that over the 1971-1981 period, eleven industry-sectors gained in their share of overall employment, while twelve lost in share. Among employers of significant size the industry-sector with the fastest growing employment was Finance, Insurance and Real Estate.

Employment of Females

Over the 1971-1981 period, females accounted for the majority (60 percent) of the additional new jobs; this reflects increasing female participation in the labour force. Figure 2.25 shows that most of these additional jobs were in the Community, Business and Personal Services sector, and in the Trade sector.

Employment growth rates for females and males are shown for all industry-sectors in Figure 2.26. Employment growth rates for females have been higher than for males in all 23 industry-sectors, though the numbers of females employed in some occupations are small.

Table 2.2 **Gains or Losses in Employment Shares by Industry-Sectors in Ontario, 1971 to 1981**
(Ranked by Employment Growth)

Ind. Code	Industry	Employment Growth (000) 1971–1981	Percentage Growth Rates		
			Gain in Share	No Change in Share	Loss in Share
22	Community, Business and Personal Services	418.4	4.5		
20	Trade	214.5	3.8		
21	Finance, Insurance and Real Estate	96.7	5.1		
23	Public Administration	50.4			1.9
18	Transportation and Storage	40.1	2.9		
9	Primary Metal and Metal Fabricating	37.2			2.4
16	Construction	32.9			1.6
19	Communication	28.5	4.3		
11	Machinery and Other Transportation	26.0	3.3		
13	Chemical, Rubber and Petroleum	25.8	3.0		
7	Wood and Furniture	21.6	3.0		
8	Paper and Allied	18.8			1.9
17	Utilities	16.9	4.1		
6	Textile and Clothing	15.6			2.7
15	Other Manufacturing	14.0			2.6
12	Electrical Products	13.7			1.8
10	Motor Vehicles and Parts	13.4			1.5
5	Food, Feed, Beverage and Tobacco	11.7			1.3
1	Agriculture, Fishing and Trapping	7.7			0.6
2	Forestry	4.9	5.3		
14	Non-Metallic Mineral Products	2.0			0.7
3	Mineral Fuels, Mines and Wells	0.8	6.7		
4	Other Mines	0.4			0.1
99	Other Industries	(102.8)			(6.1)
	All Industries	1008.6		2.8	

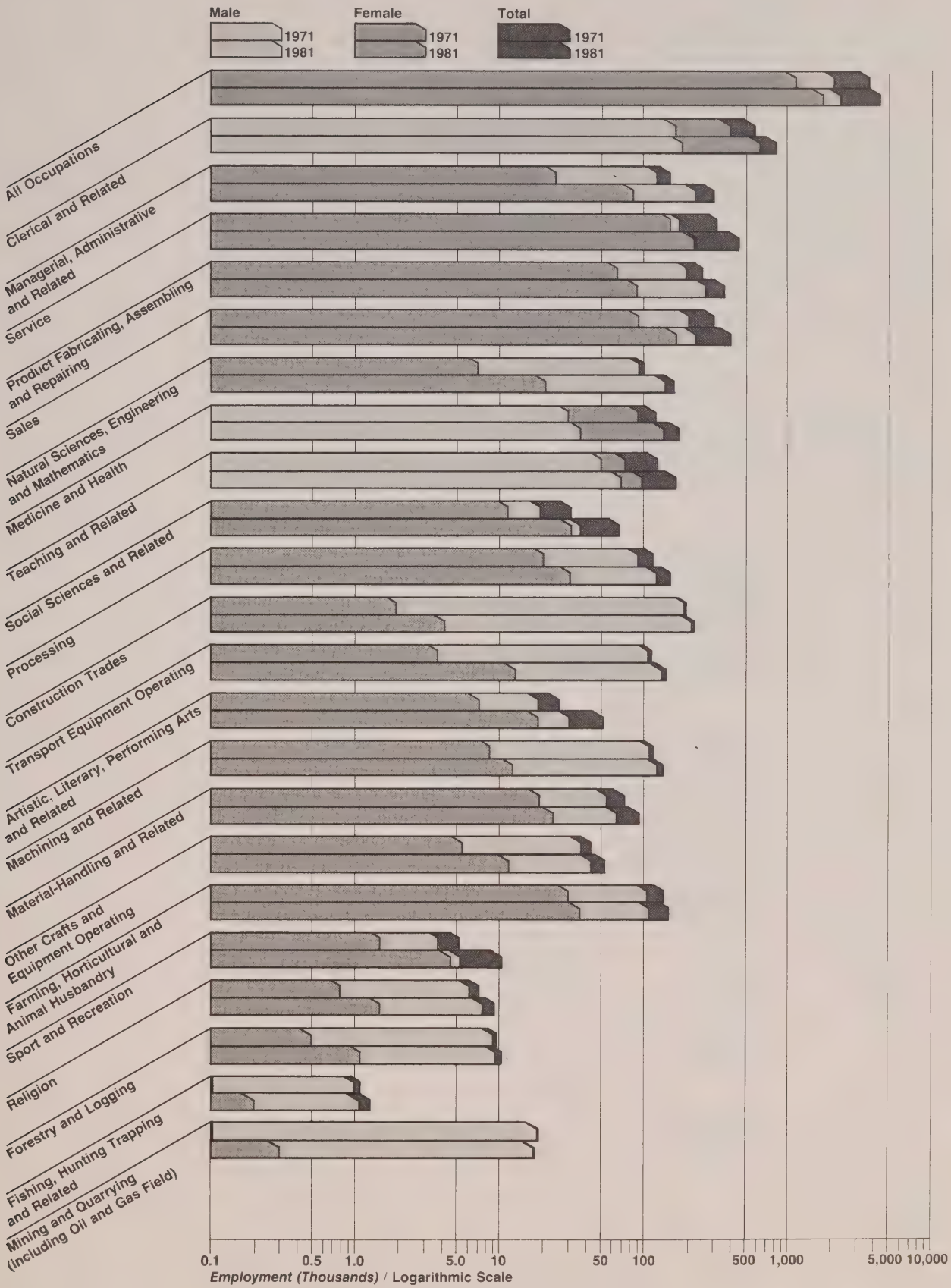
Source: Appendix 2

2.4.2 Occupational Employment Trends, 1971-1981

Occupational Employment Levels and Distribution

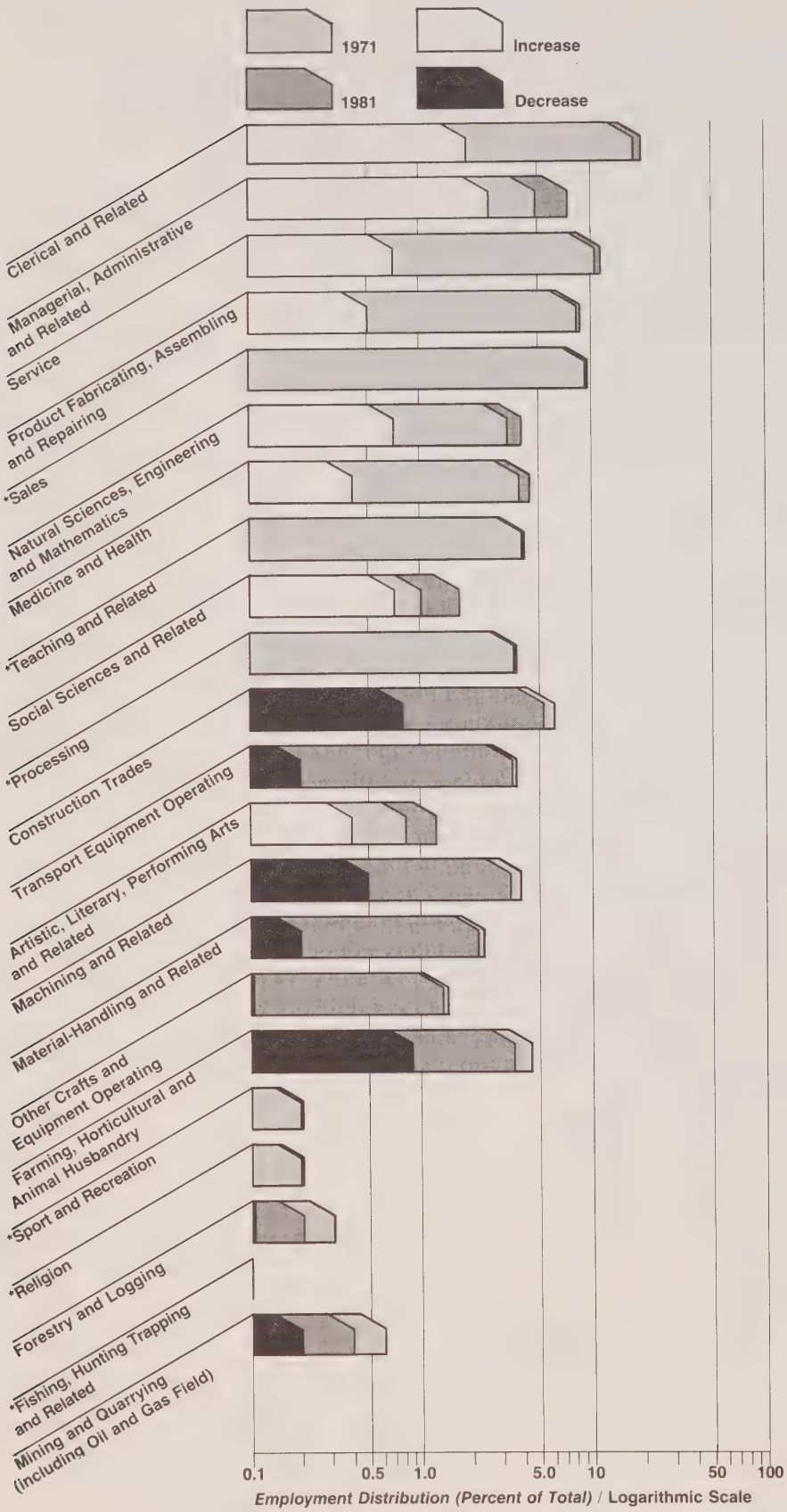
Out of a total 23 major occupational groups, the six largest occupational groups in Ontario together accounted for 62 percent of total employment in 1981. Figures 2.27 and 2.28 show that these groups were: Clerical occupations; Service occupations; Sales occupations; Product Fabricating, Assembling, and Repairing occupations; Managerial and Administrative occupations; and Construction Trades occupations.

Figure 2.27 **Employment by Occupation and Sex in Ontario, 1971 and 1981**



NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

Figure 2.28 **Distribution of Employment by Occupation in Ontario, 1971 and 1981**



*No change 1971 to 1981

NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

Occuptional Employment Growth and New Job Creation

Eighty percent of new jobs created over the 1971-1981 period in Ontario were in six major occupational groups, as shown in Figure 2.29 and Table 2.3. These groups were: Clerical occupations; Managerial and Administrative occupations; Service occupations; Product Fabricating, Assembling and Repairing occupations; Sales occupations; and Natural Sciences, Engineering, and Mathematics occupations.

Table 2.4 shows the employment growth at a finer level of occupational detail for all occupations having a total employment of 20,000 persons or more. (The first two digits of their occupational code signify to which major occupational group they belong as designated in Table 2.3.)

Occupational Employment Growth Rates and Labour Market Share

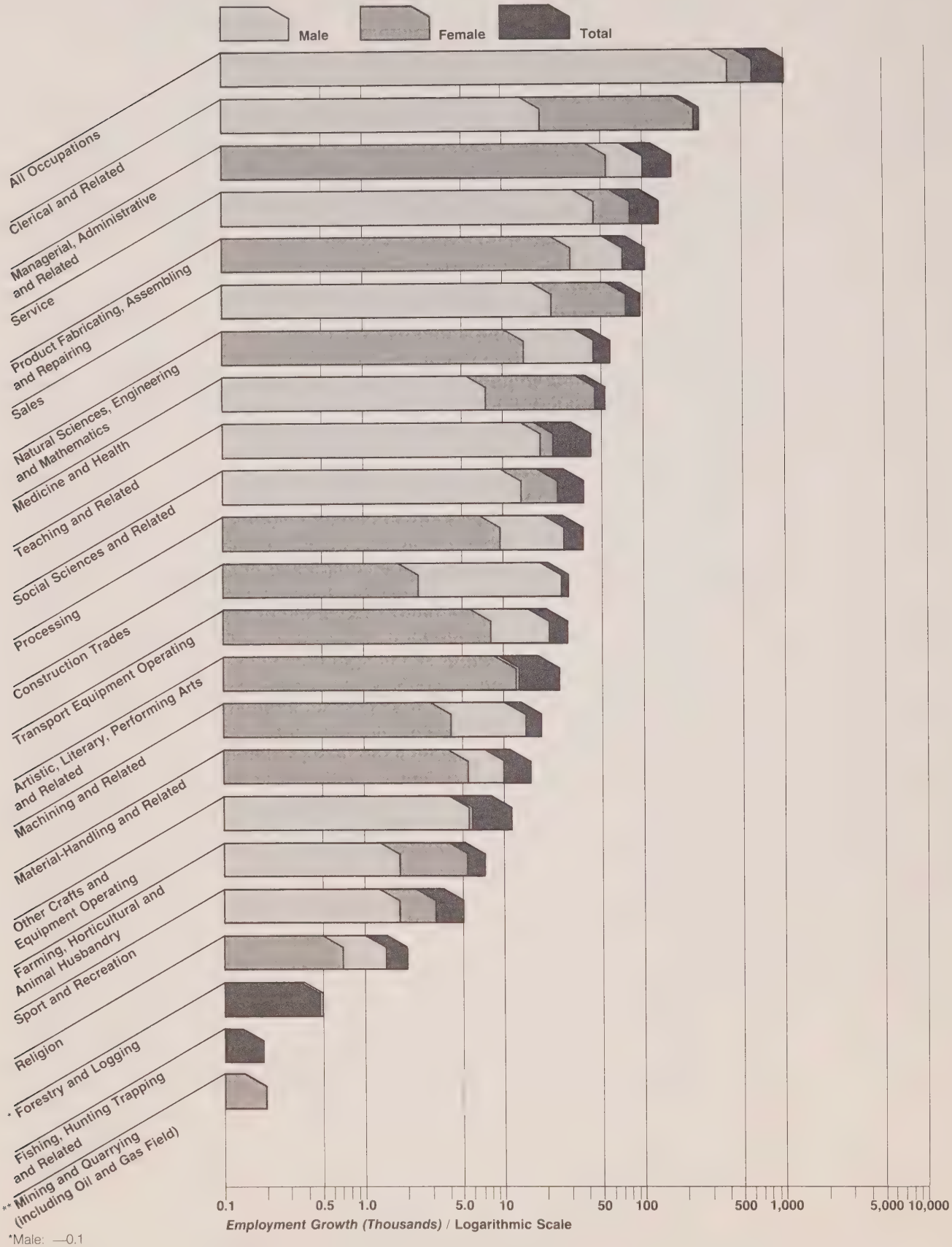
Between 1971 and 1981, overall employment grew at an annual compound rate of 2.8 percent. Occupations which grew faster than 2.8 percent increased their market share of overall employment. Over the 1971-1981 period, ten major occupational groups gained in their share of overall employment, while fourteen either stayed the same or declined in share. Figure 2.29 and Table 2.3 show that those occupational groups which gained most rapidly in market share include Social Sciences occupations, and Managerial and Administrative occupations.

Table 2.3 **Gains or Losses in Employment Shares by Occupations in Ontario, 1971 to 1981**

Occ. Code	Occupation	Employment Growth (000)	Percentage Growth Rates		
			Gain in Share	No Change in Share	Loss in Share
41	Clerical	256.1	3.9		
11	Managerial and Administrative	160.3	7.4		
61	Service	133.6	3.4		
85	Fabricating	103.7	3.4		
51	Sales	98.1		2.8	
21	Natural Sciences	59.9	4.8		
31	Medicine	54.0	3.8		
27	Teaching	40.7		2.8	
23	Social Sciences	38.0	8.3		
81	Processing	37.3	2.9		
87	Construction	29.3			1.4
91	Transportation	28.5			2.3
33	Artist	25.0	6.9		
83	Machining	18.5			1.5
93	Material Handling	15.8			1.9
95	Other Crafts	11.6			2.4
71	Farming	7.1			0.5
37	Sports	5.0	7.0		
25	Religion	2.1			2.6
75	Forestry	0.5			0.5
73	Fishing	0.2			1.6
77	Mining	(1.3)			(0.7)
99	Other Occupations	(115.2)			(4.6)
	All Occupations	1008.6		2.8	

Source: Appendix 2

Figure 2.29 **Employment Growth by Occupation and Sex in Ontario, 1971 to 1981**



*Male: —0.1
**Male: —1.5
**Total: —1.3

NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

Table 2.4 **Occupations with a Total Employment of at Least 20,000 in Ontario, 1981**

Occ. Code	Occupation	1981 Total Employed (000)	1971–1981 Growth (000)
4131	Bookkeepers	146.3	59.0
5135	Commissioned Salespersons: nec	164.3	47.2
4133	Cashiers and Tellers	84.4	40.1
4111	Secretaries and Stenos	130.8	37.7
6125	Waiters	74.4	31.3
1137	Sales Management Occupations	32.2	27.0
1149	Management: nec	35.4	25.6
3131	Graduate Nurses, Nonsupervisors	63.1	24.3
4143	EDP Equipment Operators	34.9	22.0
6121	Chefs and Cooks	43.7	21.2
1171	Financial Officers	59.0	19.9
5133	Commercial Traveller	39.7	18.9
1135	Managers: Financial	21.4	18.6
2183	Systems Analysts	28.6	17.2
1143	Production Management Occupations	20.0	16.9
8584	Industrial Farm Mechanics	33.8	14.9
4171	Receptionists	32.0	14.6
4155	Stock Clerks	37.8	14.4
6120	Supervisors: Food and Beverage Preparation	27.6	13.4
9175	Truck Drivers	84.3	13.2
6198	Labour Services	30.9	12.4
5172	Real Estate Sales	23.3	12.3
6191	Janitors	80.5	12.1
4153	Shipping Clerks	40.4	11.7
4197	General Office Clerks	48.0	10.6
8335	Welding	35.5	9.0
6115	Guards and Other Security	26.1	9.5
2731	Elementary and Kindergarten Teachers	65.8	9.4
2165	Engineering Technicians	19.8	9.1
7195	Nursery Workers	23.6	8.4
8581	Auto Mechanics	48.2	7.9
2733	Secondary Teachers	43.2	7.6
5171	Insurance Sales	20.0	6.3
8780	Supervisors: Other Construction	26.7	6.1
8563	Sewing Machine Occupations	25.1	6.0
8513	Auto Fabricating and Assembly: nec	21.2	5.2
6112	Police Officers: Govt	20.1	5.2
9317	Packing Occupations: nec	33.1	4.7
5130	Supervisors: Commissioned Sales	95.6	3.1
6143	Hairdressers	23.7	2.7
4199	Other Clerical: nec	34.4	2.5
8781	Carpenters	31.0	2.1
8313	Machinists	20.6	2.1
3135	Nursing Attendants	23.2	1.9
1130	General Managers	21.6	1.7
7112	Farmers	56.5	1.6
8798	Labour: Other Construction	22.2	0.2
4113	Typists and Clerk-Typists	41.4	(0.3)
7182	Farm Occupations: nec	49.2	(7.6)

Source: Appendix 2

Females and Occupational Employment

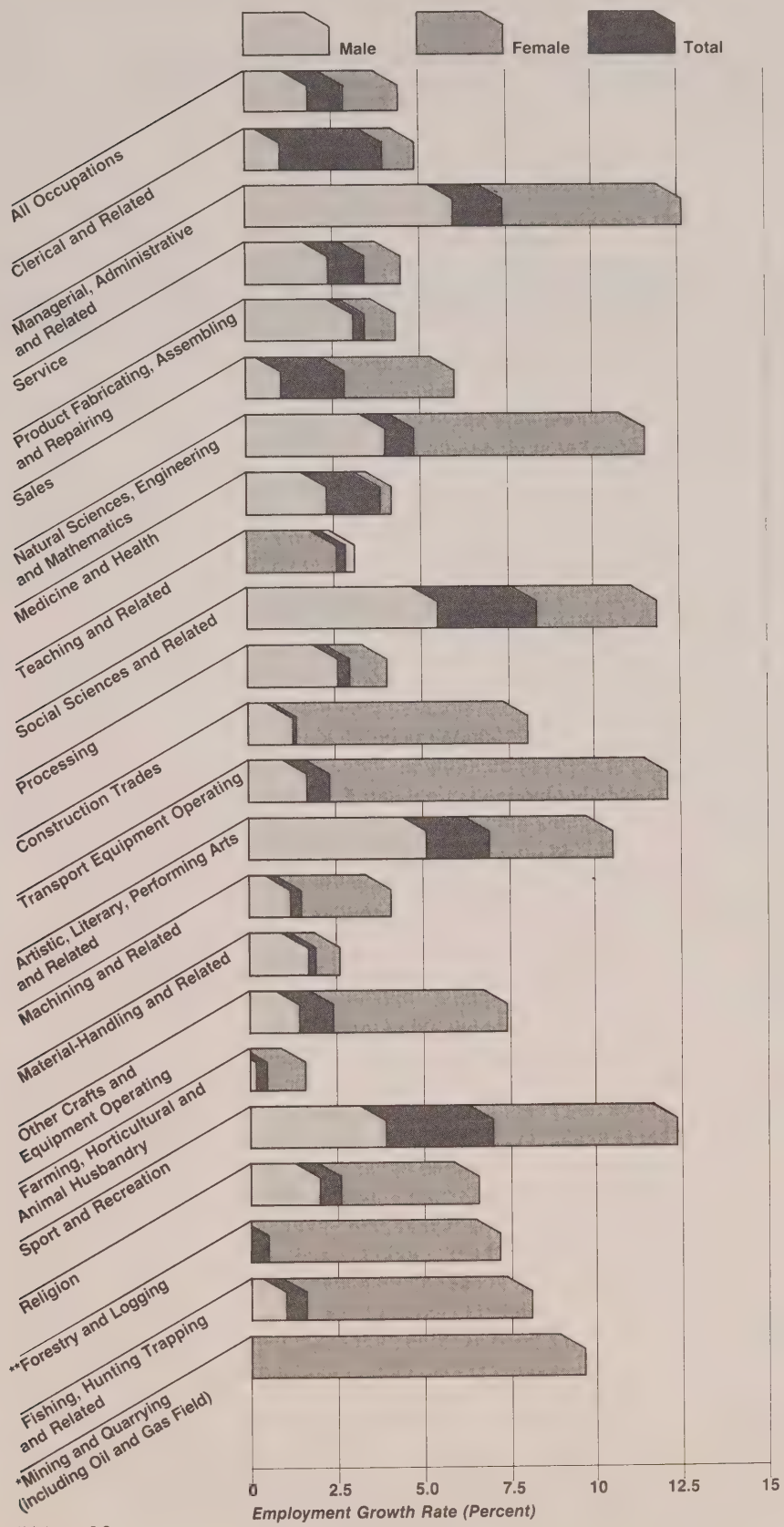
Eighty-eight percent of employment growth for females over the 1971-1981 period was concentrated in six occupational groups. Figure 2.29 shows these were: Clerical occupations; Service occupations; Sales occupations; Managerial and Administrative occupations; Medical occupations; Fabricating occupations.

Clerical, Service, and Sales occupations together accounted for almost two-thirds of employment growth for females, and Clerical occupations alone accounted for almost 40 percent of employment gains over this period. With the exception of Teaching occupations, as seen from Figure 2.30, females have had higher employment growth rates than males in every major occupational group over the 1971-1981 period.

Changes in Occupational Compositions

The proportion of total employment in any industry-sector which is employed in an occupational group is known as the occupational coefficient in that industry-sector. (For example, in 1981, in the Finance industry-sector 118,200 people were employed in the Clerical occupational group out of a total industry-sector employment of 245,800; the Clerical occupational coefficient was therefore 48.1 percent in the Finance industry-sector.) Our analysis of changes in the coefficients of all 2-digit occupational groups in all industry-sectors over the 1971-1981 period reveals that 95 percent of all changes were within plus or minus 2.83 percentage points.

Figure 2.30 **Employment Growth Rates by Occupation and Sex in Ontario, 1971 to 1981**



*Male: —0.8
*Total: —0.7
**Male: 0

NOTE Bars are one behind another with the smallest at the front.
Source: Statistics Canada, Census 1971 and 1981, and Appendix 2

Reasons for Occupational Employment Growth

Changes in the employment level of an occupational group within an industry-sector may arise for two reasons. First, a change may occur simply because the total employment level in the industry-sector has altered, affecting the employment levels of all occupational groups in the sector. Second, a change may occur because the occupational coefficient for that occupational group has changed, reflecting a change in the importance of those occupational skills within that industry-sector.

An analysis of employment growth for all 2-digit occupational groups in each

Table 2.5 **Employment Growth Due to Industry Growth and Occupational Change in Ontario, 1971 to 1981**

Ind Code	Occupation	Total Growth (000)	Managerial Administrative	Natural Sciences	Social Sciences	Religion	Teaching	Medical Health	Art and Recreation	Sports	Clerical
All Industries (000)		1009	160	60	38	2	41	54	25	5	256
Due to Ind Growth			73	38	18	4	64	62	13	3	234
Due to Occ Change			87	22	20	−2	−23	−8	12	2	22
All Industries		1009	O	I	O	I	I	I	I	I	I
1	Agriculture, Fishing and Trapping	8	O	O				O			O
2	Forestry	5	O	O							I
3	Mineral, Fuels and Mines	1	I	I							I
4	Other Mines	0	O	O	O		O				O
5	Food, Feed and Tobacco	12	O	O	O				S		I
6	Textile and Clothing	16	O	I			O	S	I		I
7	Wood and Furniture	22	I	I					I		I
8	Paper and Allied	19	O	S	O				I		I
9	Primary Metal/ Fabricating	37	O	I	S		S	S	S		I
10	Motor Vehicles and Parts	13	O	O	−O			O			I
11	Machinery and other Transportation	26	O	I			S		I		I
12	Electrical Products	14	O	I	S			S	S		I
13	Chemical, Rubber and Petroleum	26	O	I	O		O	S	S		I
14	Non-Metallic Mineral	2	O	O	S		O		O		I
15	Other Manufacturing	14	O	I	S			O	I		I
16	Construction	32	O	I							O
17	Utilities	17	O	I			S				I
18	Transportation	40	O	I	S		O	O			I
19	Communication	29	O	I	O		I	S	I		I
20	Trade	215	O	O	O		O	I	I	S	I
21	Finance, Insurance and Real Estate	97	I	I	I		O	S	I		I
22	Community, Business and Personal Services	418	I	I	I	I	I	I	I	I	I
23	Public Administration	50	O	I	O		I	−O	O	O	I

NOTES I = Change due to industry growth is greater than change due to occupational shift
O = Change due to occupational shift is greater than change due to industry growth
S = Equal change due to industry growth and occupational shift

Source: Appendix 2

industry-sector has been conducted (details in Appendix 2). Occupational employment growth has been disaggregated into components due to industry growth and occupational coefficient changes, and the results are shown in Table 2.5. For most occupational groups, employment growth has mainly arisen from industry growth. Notable exceptions are the occupational groups of Managers and Administrators, and Social Scientists, where employment growth was mainly due to increasing occupational coefficients.

Sales	Service	Farming	Fishing	Forestry	Mines Quarries	Processing	Machining	Fabricating Assembly	Construction	Transportation	Material Handling	Other Crafts
98	134	7	0	0	−1	37	19	104	29	28	16	12
130	152	13	0	4	1	30	31	85	43	35	22	13
−31	−18	−6	0	−4	−2	7	−13	18	−14	−7	−6	−1
I	I	I	S	I	−O	I	I	I	I	I	I	I
O	O	I	O	O		−O	S	O	O	O		
	I	I		I		I	S	I	I	I	S	
					I	S				S		
	O				−O	O	S	O	O	−O	−O	−O
−O	I	−O				I	−O	O	−O	I	I	−O
I	−O					I	I	I	S	I	I	S
I	I			I		I	I	I	I	I	I	S
−O	I			−O		I	−O	I	S	I	I	I
−O	I				−O	I	I	I	−O	I	I	S
−O	−O					−O	I	I	−O	−O	I	S
−O	I				S	O	I	I	I	I	I	S
−O	−O					O	−O	I	−O	S	I	S
−O	−O	S				I	I	I	I	I	I	I
S	−O					I	O	I	−O	I	I	
−O	S					I	S	I	I	I	I	I
I	I	O			−O	I	−O	O	I	−O	−O	S
−O	I	S	I			S	I	I	I	I	I	I
I	I	S		S		S	S	I	I	I	I	−O
I	I							I	I	S	S	I
I	I	−O				I	I	I	I	I	I	I
I	I	I				−O	−O	I	I	I	−O	I
I	I	I				I	I	I	I	I	I	I
−O	I	I	S	−O		S	−O	I	−O	S	−O	−O

2.5 Employment and the Recent Recession: 1982-1984

By 1982, the adverse effects of the recent recession on employment were widespread. It was an extremely painful and troubling experience for most people of Ontario, and few households were unaffected.

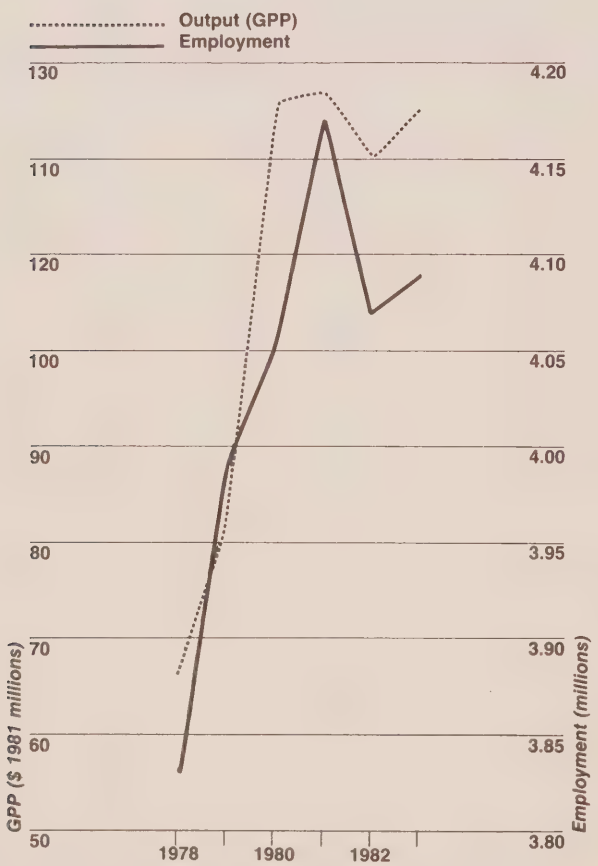
Employment in 1981, when averaged over the year, was at the level of 4,171,000; by 1982, the level had declined to 4,067,000, and by January 1985 it had risen to 4,178,000, as shown in Figure 2.31.

The magnitude of this experience, and its extraordinary nature relative to previous long-run historical situations, can clearly be judged from Figure 2.1. The reasons for this extraordinary occurrence are only now beginning to emerge.

2.5.1 Emerging Explanations for High Unemployment

Since the long-run historical record shows the interrelationship between growth in demand, productivity, output, and employment, there has been considerable debate over the causal factors behind recent unemployment levels in Canada. There are various different possible causes of unemployment. Importantly among these, unemployment may arise from deficiency in economic demand for goods and services relative to the production capacity of the economy, and from structural factors. Structural unemployment results when people have skills that are not in demand, when people do not invest in new skills for which there is a demand, and when people refuse to make themselves available at places where there is a demand for their services. Most economists tend toward the view that demand in the economy has recently been too low, thus depressing our output of goods and services and significantly affecting employment levels. It has been suggested that the economic buffeting of the turbulent 1970's has resulted in a reinforcement of Canadians'

Figure 2.31 **Employment and Output in Ontario, 1978 to 1983**



Source: Statistics Canada, *Labour Force Survey* and Ontario Ministry of Treasury and Economics, *Economic Statistics*

careful disposition to save rather than spend, and estimations have been made that the major portion of unemployment is associated with factors which have resulted in an aggregate demand deficiency.[15] These estimations also place a relatively minor importance on the contribution of all structural factors, including employment losses associated with the adoption of new technology.

Although it is not our intention to pursue this subject in detail, we recognize the emergence of economic opinion regarding the importance of demand levels in our economy and their substantial impact on overall employment. However, we also

Table 2.6 **Changes in Employment in Ontario, 1981 to 1984**

Category	Employment (000)			Employment Changes	
	Pre-Recession Peak Aug 1981	Recession Low Nov 1982	Recent Nov 1984	During Recession 1981–1982 (000)	During Recovery 1982–1984 (000)
Total Employment	4350	3969	4287	−381	+318
Adult Male (20+)	2284	2087	2260	−197	+173
Full-time	2232	2004	2161	−228	+157
Part-time	51	84	99	+33	+15
Adult Female (20+)	1552	1560	1715	+8	+155
Full-time	1279	1203	1325	−76	+122
Part-time	273	359	390	+86	+31
Young People (15–19)	515	320	312	−195	−8
Full-time	354	104	99	−250	−5
Part-time	161	216	214	+55	−2
Goods-Producing Sector	1572	1275	1390	−297	+115
Agriculture	174	125	102	−49	−23
Other Primary	72	40	48	−32	+8
Manufacturing	1078	901	1013	−177	+112
Construction	248	209	227	−39	+18
Service Sector	2777	2694	2897	−83	+203
Trade	690	681	745	−9	+64
Transportation, Storage, Communication and Utilities	308	290	283	−18	−7
Finance, Insurance and Real Estate	255	232	283	−23	+51
Business and Personal Services	1239	1222	1307	−17	+85
Public Administration	285	269	279	−16	+10
Total Employment	4350	3969	4287	−381	+318
Part-Time	483	659	703	+176	+44
Male	125	188	199	+63	+11
Female	358	471	504	+113	+33
Full-Time	3866	3310	3584	−556	+274
Male	2440	2059	2215	−381	+156
Female	1426	1251	1369	−175	+118

Source: Labour Force Survey, Special Tabulations

15 Fortin, P. Op. cit. 13.

note that viewing the overall economy provides only a general sense of employment conditions which vary widely from industry to industry and from occupational group to occupational group.

2.5.2 Changes in Employment During the Recession and Recovery

Table 2.6 shows the cumulative changes in employment experienced by different groups during the recession and the recovery period up to November 1984 (the table compares monthly data for employment in Ontario at the pre-recession peak of August 1981 with the figures for the recession low at November 1982, and with recent data for November 1984). The following observations are made:

- In the Goods-Producing sector, less than one-half of the jobs lost in the recession have so far been recovered;
- In the Service sector, the jobs lost during the recession have been recovered, together with additional growth;
- Young people holding full-time jobs were particularly hard hit during the recession, with no employment recovery yet apparent;
- Both male and female workers have lost full-time jobs during the recession, which have yet to be recovered;
- Part-time employment for all categories of workers has grown during the recession and recovery periods. The proportion of total employment represented by part-time workers has increased from 11.1 to 16.4 percent.

CHAPTER 3 3 3 3

Employment and New Technology, 1985 to 1995: Major Elements of the Task Force's Research Program

Chapter Contents

We now turn our attention to the future. The Task Force has carried out research to gather information which describes expected employment for the 1985-1995 period in Ontario. The purpose of this chapter is to describe the program's major elements and to serve as a general introduction to the subsequent chapters which report the results of this research.

3.1 Introduction

As we noted earlier, the employment effects which may be seen as being associated with technological change depend very much on an observer's position for viewing the change process. Observers of the economy positioned at the level of the firm, or at higher levels of aggregation in the economy, such as the industry, the industry-sector, or the overall economy, may see quite different effects while viewing activities connected with the same technological change process. At first sight the observations may even appear contradictory, though in fact they may be quite consistent; for example, while overall employment may be increasing the employment levels in some industries may be declining. Further, there are factors at work in the economy as a whole whose effects are not readily apparent in an examination of individual units. Thus, in order to establish a well informed picture of the extent and nature of likely employment patterns for the future, it is important to use a methodology which examines the situation at different levels of the economy, including those of the firm and industry, the industry-sector, and the overall economy. The methodology we have used for the future-oriented part of our research program meets these requirements.

Before describing the elements of our studies, we offer a note of cautionary realism.

The subject of employment and technological change is extremely complex. Even when analyses are made of past events, where facts are known with certainty, it is often not possible to disaggregate the employment effects of technological change from other contextual factors. Output, employment, investment, income distribution, profits, salaries and wages, and market structure are all being affected by, and in turn are affecting, the process of technological change. Over-simplifying this dynamic may result in distorted pictures and incorrect conclusions.

However, we have an even more difficult situation to address. Our main interest lies in the employment patterns of a future period, specifically 1985-1995. We are therefore interested in the employment consequences of events that have not yet occurred. Thus, in choosing appropriate methodologies for our research, not only must we avoid over-simplifying the problem, but also we must deal appropriately with added complexities regarding the uncertain occurrence of future events. Since no one can say with absolute certainty what employment patterns will unfold in the future, what we have chosen to do is to assemble information from a wide variety of knowledgeable sources which describe, at this point in time, expectations for likely directions and magnitudes of future employment-related changes. We have

chosen to gather much of this information from industry experts and senior managers who are involved in making strategic plans for future implementation in their industries. Further, we have used methodologies which deal explicitly with uncertainties in the data whenever this is possible, and, where appropriate, we have deliberately probed the sensitivity of apparent patterns to uncertainties in the data. Our objective is to provide useful information on what is currently viewed as the likely extent and nature of the employment implications of new technology for the 1985-1995 period.

In order to introduce our research activities we now describe the major elements of our studies and their interrelationships. We proceed sequentially to outline:

- Studies of selected firms and industries;
- Industry-sector studies;
- Studies of the overall economy.

3.2 Studies of Selected Firms and Industries

We have concentrated a substantial portion of our research effort at the levels of the firm and industry since it is at these levels that many employment-related effects of technological change may be seen most clearly. In addition, it is important that we gather information regarding expectations for the future from the industry 'front-line', where technological changes are presently being made, and where strategic plans exist or are being made for implementation during the coming decade. In this part of our work we have gathered information through a survey of management and labour in firms from more than twenty industries.

The choice of industries resulted from a process in which the survey's emphasis on technologies and occupational groups was carefully considered (see Appendix 3 for details). Initially, a determination was made of important new technology which is presently being adopted or is expected to be adopted over the next decade. It was determined that the employment effects of advanced-manufacturing technology, office automation technology, computer-based technology, and telecommunications technology should be particularly examined, as should the employment effects on eight major occupational groups spanning work activities of the shop-floor and office. The industries selected contain large employment shares of these occupational groups, and together contain about 22 percent of overall employment in Ontario. Approximately half of the industries selected for the survey were manufacturing industries, and half service industries.

The survey sought information from randomly chosen, representative samples of firms from each of the industries. The following strategic research questions have been addressed:

- What levels of future economic output does this industry expect to produce, including the effects resulting from the creation of new products and the adoption of new technology?
- What new technology is being and will be adopted to 1995?
- At what rates will this new technology be adopted?
- What are the factors which will determine the rates of adoption?
- What changes in employment levels are expected?
- What changes in occupational structure are expected?
- What skill changes are the new work-tasks going to demand?
- How will the skill changes be met?
- What is the context of management and worker relationships in which these changes will be considered?

A summary of the important information gathered is presented in Chapter 4.

Where statistical justification permits, quantitative data derived from the surveys have been drawn together in other studies at higher levels of aggregation. In particular, information regarding future employment and occupational changes has been utilized in our industry-sector studies.

3.3 Industry-Sector Studies

Our industry-sector studies cover all industry-sectors in Ontario. We have grouped total Ontario employment into 23 industry-sectors, and for each we have gathered estimates of future employment levels from a wide variety of knowledgeable sources. In addition, we provide an important link to the employment effects of technological change by developing estimated future occupational compositions for all industry-sectors, utilizing recent Labour Force Survey and Census data and data from our own industry studies.

For each industry-sector we have addressed the following strategic research questions:

- What changes in industry employment levels may be expected, 1985-1995?
- What changes in occupational compositon of employment may be expected, 1985-1995?

Data for all industry-sectors have been aggregated, so that for Ontario overall we may address the question:

- What changes in overall employment and occupational employment levels may be expected in Ontario, 1985-1995?

A summary of the important patterns apparent in these data are described in Chapter 5. One component of these industry-sector studies is a sensitivity analysis of the employment data. This analysis draws upon the results of our studies of the overall economy.

3.4 Studies of the Overall Economy

At the level of the overall economy, we have commissioned studies to estimate possible employment impacts associated with future technological change. In particular, using productivity improvements as a proxy for technological change, we have made estimates of the employment outcomes which might result in the future from different types and rates of productivity improvement. These estimates establish a range of possible overall employment outcomes which could be associated with future technological change, and utilize different scenarios of how the 'productivity dividends' resulting from technological change are shared in the economy. This range of possible overall employment outcomes has been used in our industry-sector studies to determine the sensitivity of occupational employment estimates to uncertainties of this sort.

A summary of this work is presented in Chapter 6.

CHAPTER 4 4 4 4

Employment and New Technology, 1985 to 1995: Studies of Selected Industries

Chapter Contents

4.1 Introduction

As we have argued earlier, in order to establish an informed picture of the extent and nature of the employment impacts associated with technological change, it is necessary to use a research methodology which makes observations of the change process from different vantage points, spanning the levels of the firm and industry, the industry-sector, and the overall economy.

In this chapter we report the results of our studies at the levels of the firm and industry. Since these studies comprise a survey of firms, we proceed in the following order:

- First, we describe the orientation of the survey regarding the technologies, occupational groups, and industries which were selected for study;
- Second, we report the results of this survey, proceeding by various research topics for which data were gathered, and presenting results for all the industries selected for study.

4.2 Orientation of the Studies: Technologies, Occupations, and Industries

A major element in the Task Force's research program involved a survey of firms across Ontario in more than 20 industries at the 3-digit Standard Industrial Classification (S.I.C.) level.

In the organization of this survey, there were conflicting considerations which needed to be balanced. On the one hand, since technological change touches all industries to varying degrees, it is desirable to have as broad industrial coverage as is possible. On the other hand, since technological change is a complex subject, involving different technologies and industries in very different ways, the results from a broad, uniformly-applied survey would be inconclusive. It was clear from a practical standpoint that some choices were necessary regarding this study.

In this section we describe the orientation given to our industry studies by the choice of technologies, occupational groups and industries on which the survey was focussed. (See Appendix 3 for a detailed description of the selection process.)

4.2.1 New Technology

For the purposes of the survey we focussed upon technologies which have the potential for causing significant employment changes over the 1985-1995 period.

After examination and classification of a wide range of technology groups, it was determined that the potential for causing significant employment changes during 1985-1995 primarily lay with the following four groups of new technology:

- Office Automation Technology
- Telecommunications Technology
- Computer-Based Technology
- Advanced-Manufacturing Technology

More detailed definitions of these groups are presented in Tables 4.1 through 4.4, where lists of technologies and illustrative applications are shown. Although the questionnaire used in the survey was designed around the four identified technology groups, it also offered respondents opportunities to provide additional information on other new technologies if they were thought important to their firms for the 1985-1995 period.

Table 4.1 **Office Automation Technology**

Selected Technologies	Selected Applications
Word Processor	Preparation, modification and printing of written documents
Microcomputer and Personal Computer	Data analysis, manipulation and storage, graphics, word processing
Electronic Filing Systems	Large-scale document storage
Fully Integrated Work Station	Multi-function word and data processing, microcomputer, and voice and data terminal
Local Area Network	Linkage of microcomputers so that data and software can be shared
Internal Data Base Management Systems	Organization and collection of data for various management purposes
External Data Base Services	Provision of information and data from external sources

Source: Appendix 3

Table 4.2 **Telecommunications Technology**

Selected Technologies	Selected Applications
Private Automated Branch Exchanges	Telephone switching, call forwarding, call monitoring, cost tracing, voice mail
Electronic Mail	Inter-office mail, memos, documents or reports
Video Conferencing	Remote meetings include full or partial video link, audio and data transmission
Fibre Optics	Broadband, high capacity telecommunications links, secure telecommunications facilities
Head-Office/Plant Computer Lines	Exchange of data, electronic mail, reports, memos between regionally dispersed operations
Head-Office/Customer Computer Links	Sales ordering, inventory monitoring, sales trends analysis
Videotex (Telidon)	Transmission of text or graphic information over telephone lines to normal television set equipped with special decoder
Facsimile Transmission	Transmission of document copies
Dedicated Satellite Systems	Long-distance communication between regionally-dispersed offices

Source: Appendix 3

Table 4.3 **Computer-Based Technology**

Selected Technologies	Selected Applications
Very Large-Scale Integrated Circuits	Microprocessor and memory components
Supercomputer	Long-term weather forecasting, large-scale data analysis, cryptography
Artificial Intelligence	Robotics, Advanced Machine Tools, Pattern Recognition, Computer Aided Design/Manufacturing, Computer Aided Engineering
Expert Systems	Diagnostic and Decision Support Systems in Mining, Medicine, Law, Accounting, Engineering
Fourth Generation (Natural) Programming Languages	All Present Software Applications
Voice Synthesis/Recognition	Selected Input and Output Applications
Point-of-Sale Scanning Equipment	Retail Sales Data Input, Monitoring Inventory
Electronic Funds Transfer System	Finance, Banking and Retailing
Smart Cards	Retailing, Banking
Automated Teller Machines	Banking, Retailing
Computer Decision Support Systems	All Management Areas
Customer Sales and Service Systems	Systems for delivering information services directly to customers

Source: Appendix 3

Table 4.4 **Advanced Manufacturing Technology**

Selected Technologies	Selected Applications
Computer-Aided Design (CAD)	Design, drafting, layout of manufactured products, piping, electrical or electronic circuits
Computer-Aided Engineering (CAE)	Engineering analysis and design
Computer-Aided Manufacturing (CAM)	Systems for storing and transmitting instructions between computer systems and various manufacturing tools
CAD/CAM Integration	Combines functions of both technologies above so that data from CAD can be directly transmitted to machine tool instructions
Computerized Numerically-Controlled Machine Tools	Machine tools re-programmable locally or remotely
Robotics	Pick and place, machine loading/unloading, spot welding, spray painting, palletization, assembly, fabrication
Manufacturing Resource Planning	Resource planning, ordering, monitoring and control
Automated Shop Floor Data Collection Systems	Collect data from production for other management purposes
Computerized Decision Support Systems	Assists management production, planning and design decision making
Computerized Order Entry Inventory Control	Uses sale orders to initiate work orders and monitor inventory and work in progress
Computer-Aided Inspection and Testing	Inspection and statistical quality control in all manufacturing areas
Computer-Integrated Manufacturing	Fully integrated advanced systems with CAD, CAM, and many have CAE, shop floor data collection, inventory control, resource planning faculties
Flexible Manufacturing Technologies	Small- to medium-scale batch production, allows rapid re-tooling and multi-product production on same production line—customized on off products
Computerized Process Control Systems	Monitors and controls continuous process operation
Automated Storage and Retrieval Systems	Automated conveyor and vehicle systems for inventory storage and material handling

Source: Appendix 3

4.2.2 Occupational Groups

Following the identification of the new technology groups, a related choice was made of the occupational groups which were thought particularly sensitive to the adoption of new technology, and on which the survey would therefore be focussed.

This identification process yielded eight major occupational groups. These were:

- Managerial, Administrative and Related Occupations
- Natural Sciences, Engineering and Mathematics Occupations
- Clerical and Related Occupations
- Sales Occupations
- Processing Occupations
- Machining and Related Occupations
- Product Fabricating, Assembling and Repairing Occupations
- Material Handling and Related Occupations

Again, similar to the approach utilized for new technology, although the gathering of occupational information in the survey was focussed around these eight identified groups, respondents were offered opportunities to provide information on other occupations they thought were significantly affected.

4.2.3 Industries Selected for Study

The employment impacts of technological change are expected to vary across industries due to the nature of new technology and due to the differing nature of industries' activities. In order to maximize the effectiveness of the survey, it was clear that resources should be focussed upon those industries where most employment changes might be expected to occur.

Following from the identification of the new technologies and occupational groups on which the survey would particularly focus, an analysis was conducted to determine an appropriate industry focus. This was accomplished by identifying industries containing large employment shares of the occupational groups of interest.

First, major industry-sectors were identified on this basis. The industry-sectors identified were: Primary Metal and Metal Fabrication; Motor Vehicles and Parts; Machinery and other Transportation Equipment; Electrical Products; Chemical, Rubber and Petroleum; Communication; Trade; Finance, Insurance and Real Estate; Community, Business and Personal Services; Public Administration.

Since these industry-sectors contain quite different types of industries at a finer level of classification, a further selection of industries was necessary in order to provide a sound basis for survey sampling. In general, an identification was made of 3-digit SIC code industries within these sectors which contain large employment shares of the occupations of interest.

The following industries were chosen for study:[16]

Manufacturing Industries

- Iron and Steel (SIC 291)
- Metal Fabricating (SIC 304, 306, 309)
- Machinery and Equipment (SIC 315)
- Aircraft and Aircraft Parts (SIC 321)
- Communications Equipment (SIC 335)
- Office, Store and Business Machinery (SIC 318)
- Plastics Processing (SIC 165)

Service Industries

- Chartered Banks and Trusts (SIC 701)
- Insurance (SIC 721, 735)
- Government Service (SIC 909, 931, 951)
- Telecommunications and Cable (SIC 544,545)
- Retail Trade (SIC 631, 642)
- Computer Services and Business Management Consulting (SIC 853, 867)

The levels of employment in the occupational groups of interest in these industries is shown in Table 4.5, together with the proportions which these levels represent of overall employment across all industries.

16 Since the Ontario Motor Vehicles and Parts industry was to be the subject of a separate study, sponsored by Employment and Immigration Canada, the Ontario Manpower Commission, the Automotive Parts Manufacturers Association, the United Auto Workers Union, and the Motor Vehicles Manufacturers Association, it was decided not to duplicate this effort.

The Mining industry, an important sector in Ontario, was not identified by the above criteria and was to be the subject of a national study by Employment and Immigration Canada in conjunction with the Mining Association of Canada; it was therefore also decided not to duplicate that effort.

Table 4.5 **Employed Labour Force by Selected Occupations and Industries in Ontario, 1981**

Industry/Occupation	Manag. Admin.	Natural Science	Clerical	Sales	Processing	Machine	Fabricating	Material Handling	Other Occ.	Total Occ.
Iron and Steel (SIC 291)	2	3	5	0	15	6	6	5	9	50
Metal Fabricating (SIC 304,306,309)	4	2	7	2	5	23	6	2	5	56
Machinery and Equipment (SIC 315)	4	0	7	2	1	12	8	1	6	42
Aircraft and Aircraft Parts (SIC 321)	1	2	2	0	0	2	6	0	2	15
Communications Equipment (SIC 335)	3	5	5	1	1	2	11	0	2	30
Office/Store/Business Machinery (SIC 318)	2	3	3	1	0	0	3	0	0	12
Plastics Processing (SIC 165)	2	1	2	1	3	1	9	2	2	22
Chartered Banks/Trust (SIC 701)	23	3	65	1	0	0	0	0	2	95
Insurance (SIC 721)	9	3	35	41	0	0	0	0	4	93
Telecommunications and Cable (SIC 544,545)	5	4	17	1	0	0	1	0	12	40
Trade (SIC 631,642)	5	1	66	84	0	0	3	7	29	195
Computer/Management Consultants (SIC 853,867)	6	9	8	1	0	0	1	0	2	28
Public Admin (SIC 909,931,951)	47	22	80	1	0	1	4	1	94	250
Subtotal	113	58	303	135	26	47	57	18	168	926
Other Industries	201	103	511	269	126	90	308	74	1,567	3,248
Total Industries	314	161	814	404	152	137	365	92	1,735	4,174
Selected Ind. as a % of Total Industries by Occupation	36%	36%	37%	33%	17%	34%	16%	20%	10%	22%

All figures rounded in thousands
Source: Statistics Canada, 1981 Census Data (1971 Definitions); Appendix 3

4.3 Results from the Studies

From the selected Manufacturing and Service industries, a total of 180 firms responded to the survey with representation from firms of small, medium and large employment size. The sample of firms was chosen on a representative basis and results from the survey were weighted so that they could be generalized to each industry.[17]

In the Manufacturing industries, a total of 93 firms were surveyed. The management participants who responded had an average of 16 years' work experience with their firms. Thirty unions were surveyed representing workers within firms selected for the survey. The unions' principal participants had an average of 16 years of experience with their firms.

In the Service industries, a total of 87 firms were surveyed. The management participants had an average of 14 years' experience with their firms. Eleven unions were surveyed representing workers within firms selected for the survey. The unions' principal participants had an average of 14 years with their firms.

The results are highlighted in this report. (**NOTE** According to the industries' responses, the results for 1985-1990 are based on more information than for 1990-1995.) Detailed results are presented in Appendices 4–18.

4.3.1 Outputs of Selected Industries, 1985-1995

Results concerning output for all selected industries are presented in Table 4.6. The measure of output used for the Manufacturing industries is the value of shipments and is shown in 1971 dollars. A variety of output indicators are used for the Service industries. Annual compound rates of change based on estimated levels of output are presented for historical periods and expected rates are presented for the future, 1985-1990 and 1990-1995. We observe the following:

- The effects of the recession may be seen in the slow increases or declines in output for many Manufacturing industries during 1982-1983. Similarly, the effects of the recovery are seen in the rapid increase in output for 1983-1984.
- The rates projected for the future vary according to industry.
- In the Manufacturing industries, the Iron and Steel Industry and the Plastics Fabricating Industry are the only industries expecting a slower increase of output than the 1971-1981 period. The Hardware, Tool and Cutlery Industry and the Machinery and Equipment Industry expect virtually the same rates of increase but all other industries expect considerably increased output. A very significant increase in output is expected for the Office and Store Machinery Industry and for the Communications Equipment Industry for 1985-1990 and 1990-1995.
- In the Service industries, the Chartered Banks, Trust Companies, General Insurance, Insurance Brokers, Local Government, Telegraph and Cable Systems, Food Stores and General Merchandise Stores are projecting lower rates of increase; Computer Services and Management and Business Consultants show considerably higher rates of increase.
- The Computer Services industry shows expected rates of increase in output which are very large and substantially higher than all other industries. While this new industry is currently of modest size, with the rates of increase projected the Computer Services industry will be of significant size a decade hence.

17 The studies were conducted by Currie, Coopers & Lybrand. The samples were representative for each industry excluding firms with an employment size of less than 20. Complete information regarding the methodology of the survey, including sampling and tests of reliability, are contained in Appendices 4–18. In addition, a substantial number of interviews were conducted with industry experts; their comments are also reflected in the Appendices.

Table 4.6 **Output, Selected Industries in Ontario, 1971 to 1995**

Industry	Output Measure	Levels (1971 $Millions) 1982	Annual Compound Rate of Change (Percent) Estimated 1971–1981	1982–1983	1983–1984	1984–1985	Expected 1985–1990	1990–1995
Manufacturing								
291 Iron and Steel	Shipments	1,493	3.5	7.0	13.5	3.5	2.5	2.0
304 Metal Stamping, Pressing and Coating	Shipments	643	2.0	2.5	19.5	7.5	5.5	6.0
306 Hardware, Tool and Cutlery	Shipments	249	3.0	0.0	9.0	6.5	5.0	3.0
309 Miscellaneous Metal Fabricating	Shipments	375	1.5	−4.5	5.0	5.5	2.0	2.0
315 Machinery and Equipment	Shipments	1,119	4.0	−14.5	19.0	6.5	4.5	4.5
318 Office and Store Machinery	Shipments	323	5.5	8.5	7.5	9.0	17.0	17.5
335 Communications Equipment	Shipments	976	8.5	5.0	10.5	6.0	12.5	10.5
321 Aircraft and Aircraft Parts	Shipments	289	3.5	−4.5	10.5	9.0	7.5	7.0
165 Plastics Fabricating	Shipments	654	8.0	3.0	6.5	4.5	6.5	5.5
Services								
701 Chartered Banks	Assets	33,278	7.3		1.5	8.5	4.5	3.5
701 Trust Companies	Assets	27,774[1]	8.4		8.5	6.5	6.5	7.0
721 Life Insurance	Premiums		4.1	0.0	4.0	5.0	4.5	4.5
721 General Insurance	Premiums		4.7	−1.0	1.5	2.0	2.0	2.0
735 Insurance Brokers	Premiums		3.9	−4.0	2.5	2.5	1.0	1.0
909 Federal Government	Expenditure	7,397	3.7	7.5	9.0	7.0	5.5	5.5
931 Provincial Government	GDP	748	3.2	2.0	3.5	3.5	3.5	3.5
951 Local Government	GDP	788	3.2	2.5	3.0	2.5	3.0	3.0
544 Telephone Systems	Revenue	1,374	7.7	8.0	7.5	11.0	8.0	9.0
545 Telegraph and Cable Systems	Revenue	262	6.3	3.5	5.5	3.5	2.5	2.5
631 Food Stores	Sales	3,212	0.2[2]	2.5[4]	−3.0	0.5	1.0	1.0
642 General Merchandise Stores	Sales	1,815	0.7[2]	0.0[4]	0.5	2.0	1.0	1.0
853 Computer Services	Revenue	641	8.2[2]	17.5	17.5	19.0	25.0	19.5
867 Managerial and Business Consultants	Revenue	22	2.5[3]	2.0	8.0	7.5	9.0	9.0

[1] Data for Canada, Ontario Data N.A.
[2] 1972–1981
[3] 1973–1981
[4] 1981 to 1983, actual

Source: Appendices 4 and 12–18

4.3.2 New Technology Adoption, 1985-1995

In this section we present results from the survey on new technology adoption in the industries selected for study. We present information on rates of new technology adoption, factors affecting rates of adoption, and the financial decision criteria industries take into account when planning the adoption of new technology.

Rates of New Technology Adoption

A central issue which is at the heart of the impact of technology on employment concerns the rates of adoption of new technologies. While there has been considerable speculation on this subject by writers interested in the impact of technology on employment, to date there has been little quantifiable information available. Our survey of selected Manufacturing and Service industries makes a contribution towards filling part of this knowledge gap.

Table 4.7 indicates the technologies that have been or will be adopted across all Manufacturing industries selected for study; the responses provide an indication of the rate of technology adoption. The following patterns are apparent:

- The adoption of new manufacturing-related technology has already been extensive in many manufacturing industries.
- A significant proportion of firms (40 percent or more) have already adopted new manufacturing planning and control technologies, and new manufacturing process technologies, such as: computerized financial systems, computerized order-entry/inventory-control systems, numerically-controlled machines, computer-controlled machines, telecommunication facsimile links between head-office and manufacturing plants, and computer links between head-office and plants.
- A very large proportion of manufacturing firms have already adopted computerized financial systems.
- A significant proportion of manufacturing firms are planning to adopt a wide variety of design, planning, manufacturing processes and telecommunications technologies in the period 1985-1990.
- For 1985-1990, in the design and manufacturing planning areas those technologies include: computer-aided design, computer-aided process planning, manufacturing resource planning systems, automated shop-floor data collection, computerized decision support systems, and computerized maintenance planning and control systems.
- For 1985-1990, in the manufacturing process area, a substantial proportion of firms are planning the adoption of new technologies in the areas of: computer-controlled machine tools, computer process control systems, computer-aided inspection and testing, and robotic applications.
- For 1985-1990, in the telecommunications area, a significant number of manufacturing firms are planning links between customers and suppliers.
- For 1985-1990, changes are only being planned by a relatively low proportion of firms in the material handling area.
- A much smaller proportion of firms indicate they presently have plans for the adoption of new technologies for 1990–1995 as compared to 1985–1990. (This result should not be interpreted to mean that the rate of adoption of new technology will actually slow down after 1990, since elsewhere in the survey many firms indicate their planning horizon for capital investments does not extend into this period.)

Table 4.7 **Adoption of New Technology by Selected Manufacturing Industries in Ontario, 1985 to 1995**

Technologies	Percent of Responding Firms Planning to Adopt New Technologies*		
	Before 1985	1985–1990	1990–1995
Design and Product Technologies			
Computer-Aided Design (CAD)	14	51	12
Computer-Aided Engineering (CAE)	24	28	15
CAD/CAM Integration	7	28	27
Manufacturing Planning and Control Systems			
Computerized Financial Systems	79	23	5
Computerized Order Entry/Inventory Control	67	36	7
Computer-Aided Process Planning	33	53	15
Manufacturing Resource Planning Systems (MRP)	22	51	15
Automated Shop Floor Data Collection	15	52	23
Computerized Decision Support Systems	14	52	19
Computerized Maintenance Planning and Control	12	55	20
Manufacturing Process Technologies			
Numerically Controlled Machines (NC)	65	25	8
Computer Controlled Machines (CNC)	41	41	16
CAD Directed CNC	6	33	30
Computerized Process Control Systems	33	39	7
Computer-Aided Inspection and Testing	32	51	14
Robotic Applications	14	39	26
Flexible Manufacturing Technologies	3	24	12
Computer Integrated Manufacturing (CIM)	8	24	14
Material Handling Technologies			
Automatic Bulk Handlers/Feeder Systems	35	17	9
Automated Conveyor/Vehicle Systems	25	21	10
Automated Storage and Retrieval	1	13	17
Computer Controlled Conveyor/Vehicles	1	7	10
Automated Warehouse	4	9	14
Telecommunications Technologies			
Facsimile (FAX) Link: HO/Plant(s)	48	21	7
Computer Link: HO/Plant(s)	44	33	8
Computer Link: Suppliers/Customers	19	50	14

NOTE Percentages may not add up to 100 due to multiple-responses.
*Degree of non-response can be assessed from data in Appendices 5–11.
Source: Appendix 4

Table 4.8 **Adoption of New Technology by Selected Service Industries in Ontario, 1985 to 1995**

Technologies	Percent of Responding Firms Planning to Adopt New Technologies*		
	Before 1985	1985–1990	1990–1995
Customer Sales and Service Applications			
Automated Teller Machines	41	31	16
Automatic Cheque Verification	19	30	12
Pay by Phone	0	5	43
Automatic Debit/Credit Systems	40	17	21
Computerized Loan Qualification and Approval	19	57	0
"Smart" Cards (with installed microprocessors)	0	7	27
Home Banking	5	17	33
Connection to Retail Store Point of Sale Network	7	23	16
Computerized Trust Management	27	16	5
Computerized Pension Management	33	22	5
Securities Transfer/Stock Holder Services	27	27	16
On-Line Policy/Client Data Bases	68	33	6
Computerized Insurance Needs Analysis	34	55	6
Computerized Contract Generation	48	42	6
Electronic Claims Processing Systems	50	39	0
Automatic Insurance Verification	49	28	2
Computerized Rating/Underwriting	30	67	0
Brokerage Management Systems	38	44	2
On-Line Terminal for Group Insurance Customers	0	41	21
Other	6	10	2
Customer and Service Delivery or Service Delivery Technologies			
Computerized Service Order Processing	30	54	0
Computerized Client Accounts	76	27	0
Automated Diagnostics (Remote Maintenance)	52	23	16
Customized Telecommunications Systems	36	0	0
Voice Synthesis Applications	0	20	36
Voice Recognition Applications	0	36	21
Installed Customized Software Systems	83	45	8
Installed Customized Hardware Systems	45	55	8
On-Line Client Access to Data Bases	30	32	48
On-Line Interactive System with Clients	36	38	36
Direct Data Entry from Field	69	36	0
Electronic Service Delivery	25	34	7
Electronic Processing Service Request	45	19	7
Other	0	3	0
Design Technologies			
Computer-Aided Design (CAD)	15	29	3
Computer-Aided Engineering (CAE)	12	24	3
Computer-Aided Mapping	33	35	0
Computer-Aided Project Management	59	41	0
Fourth Generation Computer Languages	35	55	9
Other	5	4	0

Table 4.8 *continued*

Technologies	Percent of Responding Firms Planning to Adopt New Technologies*		
	Before 1985	1985–1990	1990–1995
Electronic Funds Transfer (EFT)			
Electronic Funds Transfer (EFT) Interbranch	50	33	17
Electronic Funds Transfer (EFT) Interbank	44	16	23
EFT Corporate Accounts	24	26	23
EFT Commercial and Retail Accounts	14	22	17
Other	0	0	4
Technologies Within the Store			
Computerized Inventory Control	47	45	5
Office or Office Automation Technologies			
Mainframe/Minicomputers	86	20	3
Word Processing	95	16	4
Electronic Filing	31	52	8
Microcomputers/Personal Computers	88	18	5
Interval Data Base Management Systems	63	35	4
Local Area Networks (LANs)	28	56	7
Computerized Decision Support Systems	36	48	12
Voice Activated Computers	2	22	40
Artificial Intelligence/Expert Systems	3	20	38
Integrated Work Stations	11	60	18
Data Base Services (External)	73	18	0
Home Terminals	17	29	0
Other	2	2	2
Telecommunications Technologies			
Private Automatic Branch Exchange (PABX)	51	32	8
Electronic Mail	39	50	10
Voice Mail	5	40	24
Facsimile with Built-in Microprocessor (FAX)	28	30	19
Satellite/Microwave Systems	8	12	28
Videotec	14	20	24
Video Conferencing	10	33	29
Fibre Optics	3	27	24
Other	2	1	2

NOTE Percentages may not add up to 100 due to multiple responses.
*Degree of non-response can be assessed from data in Appendices 13–18.
Source: Appendix 12

Table 4.8 indicates the technologies that have or will be adopted across the selected Service industries. The following patterns are apparent:

- The adoption of new office-related technology has already been extensive in many Service industries.
- Office automation technologies have been the most widely adopted technologies. Practically all firms across the Service industries indicated they had already adopted word processors by 1985. Similarly, very large proportions of firms had adopted microcomputers, mainframe or minicomputers, and data base management systems.
- A significant proportion of firms (40 percent or more) had already adopted a wide range of customer and service delivery technologies, including: computerized client accounts, direct data entry, and on-line data-bases.
- A significant proportion had also adopted the following customer sales applications: automated teller machines, computerized loan qualification and approval, on-line policy/client data bases, electronic claims processing systems, and automatic insurance verification.
- In other technology areas, by 1985 a significant proportion of firms had adopted: computer-aided project management, electronics funds transfer, computerized inventory control and automatic branch exchanges (PABX).
- With regard to the future, a significant proportion of firms indicate widespread adoption of a range of technologies in all major categories over the 1985-1990 period. A smaller proportion of firms indicate plans for the following five years, 1990 to 1995, but this is probably because elsewhere they indicate their average planning cycle is four years.

Table 4.9 shows the extent to which the individual Manufacturing industries selected for study have adopted or plan to adopt new technologies by 1990. The following observations can be made:

- By 1985, the Iron and Steel Industry had adopted a wide variety of new technologies. The industry also indicates plans for extensive adoption for the 1985-1990 period.
- In general, all other industries indicate a somewhat more particular range of technologies which they had adopted by 1985, and which they plan to adopt in the period 1985-1990.
- In the Metal Stamping, Pressing and Coating Industry no significant proportion of firms show as planning technological change in 1985-1990, except in regard to computerized maintenance planning and control, and telecommunication computer links with customers and suppliers. However, other segments of the same Metal Fabricating industry-sector, such as the Hardware, Tool and Cutlery Industry, and the Miscellaneous Metal Fabricating Industry, both indicate significant proportions of firms planning to adopt a wider range of design, manufacturing process and planning technologies during the period 1985-1990.
- The Communications Equipment Industry has already adopted a wide range of technologies, and no clear patterns of firms' intentions are evident for the 1985-1995 period except for robotic applications.
- The Aircraft and Aircraft Parts Industry, the Miscellaneous Machinery and Equipment Industry, and the Office and Store Machinery Industry are planning a significant number of changes in the design and manufacturing technology areas.
- Regarding particular technologies, it is interesting to note that industries in the Primary Metal and Metal Fabricating Sector all plan to adopt telecommunication computer links between customers and suppliers by 1990.

Table 4.9 **Selected Manufacturing Industries in Which 50% or More of Firms Plan to Adopt New Technology by 1990**

Industry	Before 1985 (SIC 3-Digit Industries)									1985–1990 (SIC 3-Digit Industries)								
	291	304	306	309	315	318	335	321	165	291	304	306	309	315	318	335	321	165
Design and Product Technologies																		
Computer-Aided Design (CAD)										X		X		X	X			X
Computer-Aided Engineering (CAE)	X						X						X		X			
CAD/CAM Integration												X	X					
Manufacturing Planning and Control Systems																		
Computerized Financial Systems	X	X	X	X	X		X	X	X									
Computerized Order Entry/Inventory Control	X	X	X		X	X	X	X	X				X					
Computer-Aided Process Planning	X											X	X	X	X		X	
Manufacturing Resource Planning Systems (MRP)										X			X	X	X		X	
Automated Shop Floor Data Collection	X												X	X			X	X
Computerized Decision Support Systems										X		X	X	X			X	X
Computerized Maintenance Planning and Control	X									X	X		X		X	X	X	X
Manufacturing Process Technologies																		
Numerically Controlled Machines (NC)	X		X	X	X			X		X								
Computer Controlled Machines (CNC)			X	X				X		X		X						
CAD Directed CNC																		
Computerized Process Control Systems	X								X	X							X	X
Computer-Aided Inspection and Testing	X						X	X		X		X	X					X
Robotic Applications														X		X		X
Flexible Manufacturing Technologies																		X
Computer Integrated Manufacturing (CIM)																		
Material Handling Technologies																		
Automatic Bulk Handlers/Feeder Systems	X	X							X				X					
Automated Conveyor/Vehicle Systems	X								X									
Automated Storage and Retrieval																		
Computer Controlled Conveyor/Vehicles																		
Automated Warehouse																		
Telecommunications Technologies																		
Facsimile (FAX) Link: HO/Plant(s)	X			X	X		X											
Computer Link: HO/Plant(s)	X						X											
Computer Link: Suppliers/Customers										X	X	X	X					

Source: Data in Appendix 4

Table 4.10 **Selected Service Industries in Which 50% or More of Firms Plan to Adopt New Technology by 1990**

Industry	Before 1985 (SIC 3-Digit Industries)												1985–1990 (SIC 3-Digit Industries)											
	701B	701T	721L	721G	735	909	931	951	544	545	853	867	701B	701T	721L	721G	735	909	931	951	544	545	853	867
Customer Sales and Service Applications																								
Automated Teller Machines														X										
Automatic Cheque Verification														X										
Computerized Loan Qualification and Approval														X										
On-Line Policy/Client Data Bases			X	X		X		X																
Computerized Insurance Needs Analysis															X	X								
Computerized Contract Generation			X	X													X							
Electronic Claims Processing Systems			X	X													X							
Automatic Insurance Verification			X	X																				
Computerized Rating/Underwriting															X	X	X							
Brokerage Management Systems					X										X	X								
On-line Terminal for Group Insurance Customers															X									
Customer and Service Delivery Technologies																								
Computerized Service Order Processing										X											X			
Computerized Client Accounts									X	X														
Customized Software Systems											X	X												X
Customized Hardware Systems												X											X	X
Automated Diagnostics (Remote Maintenance)									X															
Direct Data Entry from Field						X	X	X																
Electronic Processing Service Delivery						X													X					
On-line Client Access and Data Bases							X				X												X	
On-line Interactive System with Client											X												X	

Design Technologies																											
Computer-Aided Design																					X						
Computer-Aided Engineering										X											X						
Computer-Aided Mapping																					X						
Computer-Aided Project Management						X	X														X						
4th Generation Computer Language			X			X	X						X		X			X	X			X	X	X		
Electronic Funds Transfer																											
Electronic Funds Transfer Interbranch	X												X														
Electronic Funds Transfer Interbank	X																										
Office Automation Technologies																											
Mainframe/Minicomputers	X	X				X	X	X			X	X															
Word Processing	X	X	X	X	X	X	X	X	X	X	X	X															
Electronic Filing				X			X						X	X	X					X	X		X			X	
Microcomputers/Personal Computers	X	X	X	X	X	X	X	X			X	X															
Data Base Management Systems	X	X	X	X	X	X	X			X	X			X							X					X	
Local Area Networks								X			X		X	X		X		X	X				X			X	
Computerized Decision Support Systems			X	X			X			X			X		X			X	X								
Artificial Intelligence/Expert Systems																							X				
Integrated Work Stations													X	X	X	X		X	X				X	X	X		
Data-Base Services (External)						X	X	X			X	X				X											
Telecommunications Technologies																											
Private Automatic Branch Exchange (PABX)	X		X	X		X	X		X	X	X			X						X			X				
PABX (Voice/Data)																											
Electronic Mail			X			X			X	X			X	X		X	X			X	X		X	X	X		
Facsimile with Built-In Microprocessor (FAX)						X				X										X							
Voice Mail															X			X				X					
Satellite/Microwave Systems										X																	
Video Conferencing							X						X	X						X							
Fibre Optics										X								X		X			X				

Source: Data in Appendix 12

Table 4.11 **Factors Driving Selected Industries to Adopt New Technology**

Industry	Driving Factors, Ranked in Descending Order of Importance		
	First	Second	Third
Manufacturing			
291 Iron and Steel	Competitive Pressures	Productivity/Management Information/Lower Costs	Increase Quality
304 Metal Stamping, Pressing and Coating	Lower Costs	Competitive Pressures	Increase Quality
306 Hardware, Tool and Cutlery	Competitive Pressures	Customer Demands for Changes	Lower Costs
309 Miscellaneous Metal Fabricating	Lower Costs	Competitive Pressures	Customer Demands for Changes
315 Machinery and Equipment	Lower Costs	Competitive Pressures/ Customer Demands for Changes	Increase Productivity
318 Office and Store Machinery	Competitive Pressures/ Customer Demands for Changes	Increase Quality	Strategic
335 Communications Equipment	Competitive Pressures	Lower Costs	Increase Productivity/ Enter New Markets/ Growth
321 Aircraft and Aircraft Parts	Competitive Pressures	Customer Demands for Changes	Strategic
165 Plastics Fabricating	Competitive Pressures	Increase Quality	Strategic/Enter New Markets/Growth
Services			
701 Chartered Banks	Competitive Pressures	Increase Management Information	Increase Profitability
701 Trust Companies	Lower Costs	Competitive Pressures	Increase Skills and Organizational Capacity
721 Life Insurance	Competitive Pressures	Customer Demands for Changes	Increase Productivity/ Enter New Markets/ Growth
721 General Insurance	Competitive Pressures	Increase Productivity	Customer Demands for Changes
735 Insurance Brokers	Competitive Pressures	Increase Productivity	Customer Demands for Changes
909 Federal Government	Increase Productivity	Increase Skills and Organizational Capacity	Lower Costs
931 Provincial Government	Increase Productivity	Customer Demands for Changes	Lower Costs/Increase Skills and Organizational Capacity
951 Local Government	Increase Productivity	Lower Costs	Increase Management Information
544 Telephone Systems	Increase Quality/Increase Skills and Organizational Capacity	Increase Management Information	Competitive Pressures/ Customer Demands for Changes/Lower Costs/ Enter New Markets/ Growth/Obsolescence
545 Telegraph and Cable Systems	Increase Productivity	Increase Skills and Organizational Capacity	Enter New Markets/ Growth/Customer Demands for Changes

Table 4.10 shows the extent to which individual Service industries have adopted or plan to adopt new technologies by 1990. The following observations may be made:

- A fairly wide range of office automation technologies and customer and service delivery technologies had already been adopted by 1985 in many of the selected Service industries.
- The Banking Industry has adopted electronic funds transfer systems and office automation technologies, while the Insurance Industry has adopted a variety of customer service technologies and office automation.
- With regard to the next ten years, further introduction of office automation technology and telecommunications technologies are being planned by almost all industries; the Banking and Insurance Industries are also planning introduction of a variety of customer sales and service applications.

Factors Affecting Rates of Adoption

In order to assess the forces which are driving the need for the adoption of new technologies over the next decade, firms were asked an open-ended question to name the three most important factors, from their internal or external environment, which could accelerate their need to adopt new technologies. The results of this question are presented in Table 4.11.

- Various economic and market factors are the most frequent responses by all Manufacturing industries. "Competitive Pressures" was cited as the single most important factor by the majority of industries; "Lower Costs," and "Customer Demand for Changes," were also cited as important factors.
- Economic considerations were also most frequently cited by respondents in the Service industries in regard to the factors driving the adoption of new technology. "Increased Productivity," "Competitive Pressures" and "Lower Costs" were the most critical driving factors. Among other less frequently cited factors were "Customer Demand for Changes," "Increased Skills and Organizational Capacity" and "Increased Management Information."

Table 4.11 *continued*

Industry	Driving Factors, Ranked in Descending Order of Importance		
	First	**Second**	**Third**
Services *continued*			
631 Food Stores	Lower Costs	Competition	Increase Productivity
642 General Merchandise Stores	Lower Costs	Competition	Increase Productivity
853 Computer Services	Customer Demands for Changes/Lower Costs	Enter New Markets/ Growth	Increase Skills and Organizational Capacity
867 Management and Business Consultants	Competitive Pressures	Lower Costs	Increase Management Information

Source: Appendices 4 and 12

Similarly, firms were asked an open-ended question to name the three most important factors which could slow down their rate of technology adoption over the next ten years; the results are presented in Table 4.12.

- The majority of responses from Manufacturing industries indicated economic or financial considerations as being most important. "Poor Economic Conditions" was the most frequent first choice, followed by the "Ability to Finance/Profitability." Other factors cited in declining order of importance were "Cost of New Technology," the "Competitive Environment" and the "Lack of Skills to Implement."
- Since this was an open-ended question, it is of some importance to note which factors were not mentioned. For example, resistance by labour to the adoption of new technology was not cited by spokesmen from any manufacturing industry.
- Among the Service industries, "Ability to Finance" was the most frequent factor cited that could impede the rate of new technology adoption. The "Cost of New Technology" and the "Lack of Skills to Implement" were also seen as important factors. "Unwillingness to Change," was also cited by a number of industries in the Service sector.

Table 4.12 **Factors That Could Impede the Rate of New Technology Adoption in Selected Industries**

Industry	Impeding Factors, Ranked in Descending Order of Importance		
	First	Second	Third
Manufacturing			
291 Iron and Steel	Lack of skills and know how to implement	Ability to finance	Competitive environment
304 Metal Stamping, Pressing and Coating	Cost of new technology	Ability to finance	Competitive environment
306 Hardware, Tool and Cutlery	Poor economic conditions	Competitive environment	Cost of new technology
309 Miscellaneous Metal Fabricating	Poor economic conditions	Competitive environment/ Ability to finance	Lack of skills and know how to implement
315 Machinery and Equipment	Poor economic conditions	Ability to finance	Competitive environment
318 Office and Store Machinery	Poor economic conditions	Ability to finance	Lack of skills and know how to implement
335 Communications Equipment	Poor economic conditions	Ability to finance	Lack of skills and know how to implement
321 Aircraft and Aircraft Parts	Poor economic conditions	Ability to finance	Cost of new technology
165 Plastics Fabricating	Poor economic conditions	Cost of new technology	Ability to finance/Lack of standardization
Services			
701 Chartered Banks	Cost of new technology	Poor economic conditions/ Lack of skills and know how to implement	Lack of Government assistance
701 Trust Companies	Lack of skills and know how to implement	Ability to finance	Cost of new technology
721 Life Insurance	Cost of new technology	Lack of skills and know how to implement	Unwillingness to change
721 General Insurance	Cost of new technology	Lack of skills and know how to implement	Ability to finance
735 Insurance Brokers	Cost of new technology	Ability to finance	Poor economic conditions
909 Federal Government	Ability to finance	Lack of skills and know how to implement	Lack of new technology standardization
931 Provincial Government	Ability to finance	Lack of skills and know how to implement	Unwillingness to change
951 Local Government	Ability to finance	Unwillingness to change	Lack of skills and know how to implement
544 Telephone Systems	Cost of new technology	Ability to finance/Poor economic conditions	Lack of skills and know how to implement
545 Telegraph and Cable Systems	Poor economic conditions	Ability to finance	Competitive environment
631 Food Stores	Cost of new technology/ Ability to finance	Lack of skills and know how to implement	Lack of new technology standardization
642 General Merchandise Stores	Cost of new technology/ Ability to finance	Lack of skills and know how to implement	Lack of new technology standardization
853 Computer Services	Ability to finance/lack of skills/cost of new technology	Lack of Government assistance/Poor economic conditions	Competitive environment/ Unwillingness to change
867 Management and Business Consultants	Ability to finance	Cost of new technology	Unwillingness to change/ Poor economic conditions

Source: Appendices 4 and 12

Investment in New Technology

Related to the consideration of factors which could either speed-up or slow-down the adoption of new technologies are the criteria firms utilize in order to justify financial investment in new technology. Table 4.13 shows average pay-back periods, and rates-of-return on investment, used by industries to support their decision-making processes.

- A large proportion of firms indicated that the pay-back period was an important criterion for justifying financial investment in new technology. In this connection, the period within which firms expect new technology to pay for itself is approximately three to four years.
- Return on investment calculations are also used by a significant proportion of firms for supporting their decision-making processes. Rates required for new technology investments vary between industries, with a median rate in the order of 20 percent.

Table 4.13 **Justifying Financial Investments in New Technology**

Industry	Pay-Back Period		Return on Investment (ROI)	
	Percent of Firms Using Pay-Back	Average Period (Years)	Percent of Firms Using ROI	Average Rate (Percent)
Manufacturing				
291 Iron and Steel	65	3.0	100	9
304 Metal Stamping, Pressing and Coating	100	3.5	50	28
306 Hardware, Tool and Cutlery	70	4.0	70	32
309 Miscellaneous Metal Fabricating	80	5.0	20	30
315 Machinery and Equipment	90	3.5	10	17
318 Office and Store Machinery	75	2.5	30	13
335 Communications Equipment	75	4.0	85	22
321 Aircraft and Aircraft Parts	50	3.5	60	21
165 Plastics Fabricating	75	3.0	40	26
Services				
701 Chartered Banks	55	3.0	40	—
701 Trust Companies	80	3.0	45	13
721 Life Insurance	65	3.0	85	16
721 General Insurance	70	3.5	15	—
735 Insurance Brokers	55	4.5	15	15
909 Federal Government	25	3.0	0	—
931 Provincial Government	100	3.5	35	15
951 Local Government	70	4.0	0	—
544 Telephone Systems	0	5.0	20	19
545 Telegraph and Cable Systems	0	—	50	16
631 Food Stores	—	—	—	—
642 General Merchandise Stores	—	—	—	—
853 Computer Services	65	3.5	65	20
867 Management and Business Consultants	35	2.5	60	25

Source: Appendices 4 and 12

Table 4.14 shows the proportions of capital investment plans for 1985-1995 represented by new technology and the source of financing for new technology.

- In general, these data suggest that a large proportion of capital spending over the next five years will be on Machinery and Equipment rather than new buildings, and that a substantial fraction of that spending will be associated with new technology. Financing is expected to come mainly from internal funds but smaller firms will likely be more reliant on external sources.

Table 4.14 **Industries' Capital Investment Plans in Ontario, 1985 to 1990**

Industry	Estimated Investment in Machinery and Equipment		Source of Funds For New Technology Spending
	Percent of Total Capital Investment	Percent Related to New Technology	Percent from Internal Funds
Manufacturing			
291 Iron and Steel	80	55	75
304 Metal Stamping, Pressing and Coating	75	45	75
306 Hardware, Tool and Cutlery	50	70	70
309 Miscellaneous Metal Fabricating	80	55	50
315 Machinery and Equipment	100	40	85
318 Office and Store Machinery	100	75	65
335 Communications Equipment	85	50	85
321 Aircraft and Aircraft Parts	80	60	60
165 Plastics Fabricating	70	50	60
Services			
701 Chartered Banks	90	85	100
701 Trust Companies	95	80	70
721 Life Insurance	95	65	100
721 General Insurance	40	70	100
735 Insurance Brokers	65	75	85
909 Federal Government	85	65	85
931 Provincial Government	95	60	70
951 Local Government	10	25	70
544 Telephone Systems	90	65	80
545 Telegraph and Cable Systems	100	95	100
631 Food Stores[1]	75	25	80
642 General Merchandise Stores	—	—	—
853 Computer Services	90	90	75
867 Management and Business Consultants	100	70	85

[1] Based on expert interviews.
Source: Appendices 4 and 12

4.3.3 Employment in Selected Industries, 1985-1995

The extent and nature of future employment impacts associated with the introduction and adoption of new technology is the central focus of this survey of industries. In any consideration of employment impacts several dimensions must be considered including employment levels, changes in occupational structure, and skill changes. In this section we report the results of the survey regarding changes in the levels of total employment across the selected industries, and we also include information on changes expected in the organization of work regarding full- and part-time employment. In addition, we report factors which industries identify as being important regarding their effects on levels of employment in their firms over the next ten years.

Total Employment

Table 4.15 shows the employment levels of the selected Manufacturing and Service industries for 1981 and 1982. Annual compound rates of change for the past periods 1981-1984, 1984-1985, and expected for the future periods, 1985-1990 and 1990-1995, are also presented. The following trends are apparent:

- The effects of the recession are apparent in the annual compound rates of employment change for 1981-1984 for most industries. Many industries experienced losses in employment, including: Iron and Steel, Hardware, Tool and Cutlery, Miscellaneous Metal Fabricating, Machinery and Equipment, Aircraft and Aircraft Parts, Trust companies, the Provincial Government, and Telephone Systems.
- Industries which experienced high rates of employment growth during the recessionary period were Plastics Fabricating and Computer Services.
- The extent of the recovery is reflected in the rates of employment change for 1984-1985. Most Manufacturing industries experienced gains in employment although not all recovered the losses experienced during the recession; notably, Iron and Steel, and Machinery and Equipment. Communications Equipment experienced a significant loss of employment during this period.
- Among the Service industries, the Trust Companies have not yet recovered employment losses, and the employment levels for the Provincial Government and for Telephone Systems have continued to decline.
- Computer Services experienced substantial rates of employment increases from 1981 through 1985, apparently at an accelerating pace.
- Most industries are projecting employment increases for the period 1985-1995.
- The annual rates of employment change expected for the 1985-1990 period are modest for most industries and generally tend to be somewhat lower than for 1984-1985 though there are some notable exceptions. Communications Equipment expects a strong employment recovery and, together with Office and Store Machinery, continued employment growth through the coming decade. Among the Service industries, no employment growth is expected in the Chartered Banks and continued losses are expected in the Provincial Government and in Telephone Systems. Further very substantial rates of employment increases are expected for the Computer Services industry.

Table 4.15 **Employment Trends in Selected Industries in Ontario, 1971 to 1995**

Industry	Employment Level		Annual Compound Rates of Change			
	Actual		Estimated		Expected	
	1981 (000)	1982 (000)	1981–1984	1984–1985	1985–1990	1990–1995
Manufacturing						
291 Iron and Steel		41.6	−7.0	2.5	1.0	0.5
304 Metal Stamping, Pressing and Coating		17.7	3.5	0.5	1.0	1.0
306 Hardware, Tool and Cutlery		12.8	−0.5	5.5	2.5	1.5
309 Miscellaneous Metal Fabricating		12.2	−3.5	4.5	0.5	0.0
315 Machinery and Equipment		36.9	−1.0	0.0	2.5	2.0
318 Office and Store Machinery		10.5	2.5	5.0	4.0	3.5
335 Communications Equipment		28.1	4.0	−6.5	3.0	4.5
321 Aircraft and Aircraft Parts		12.7	−7.5	9.5	−0.5	1.0
165 Plastics Fabricating		19.2	9.0	7.5	3.0	1.0
Services						
701 Chartered Banks	65.7		0.5	1.0	0.0	0.0
701 Trust Companies	28.4		−2.0	0.5	1.0	1.0
721 Life Insurance	32.1		1.0	0.0	2.0	1.0
721 General Insurance	20.5		0.0	1.5	1.5	1.5
735 Insurance Brokers	31.3		1.0	2.5	2.5	1.5
909 Federal Government	105.4		1.5	3.5	0.0	0.5
931 Provincial Government	65.8		−0.5	−0.5	−1.0	−0.5
951 Local Government	80.4		5.5	2.5	1.5	1.0
544 Telephone Systems	37.9		−2.0	−3.0	0.0	−0.5
545 Telegraph and Cable Systems	2.4		1.0	2.5	2.5	2.5
853 Computer Services	16.8		13.5	20.0	21.5	12.5
867 Management and Business Consultants	11.0		1.0	6.5	4.5	3.5

Source: Appendices 4 and 12

Part-Time Employment

Manufacturing industries have historically had low levels of part-time employment, while the proportion of part-time work in some Service industries has been significant. Table 4.16 shows current levels of part-time employment estimated by industry respondents from the selected Manufacturing and Service industries, and trends which they expect for 1990 and 1995. We observe the following:

- Among the Manufacturing industries, the percentage of part-time workers tends to be low, less than 5 percent, and most industries do not expect much change.
- Among the Service industries, some industries have significant levels of part-time employment, notably the Retail Trade Industry, Chartered Banks, Trust Companies, General Insurance, Provincial Government, and Local Government. Among these industries the Chartered Banks, Trust Companies, and Food Stores have had increases in the proportion of part-time workers over the 1981-1985 period. In general, only modest changes are expected for the 1985-1995 period. The Chartered Banks expect the present level to slightly increase; Trust Companies and Life Insurance see the trend of increasing part-time work continuing into the 1985-1995 period.

Table 4.16 **Part-Time Employment in Selected Industries in Ontario, 1981 to 1995**

		Percent of Total Employment				
		Estimated			Expected	
	Industry	1981	1984	1985	1990	1995
	Manufacturing					
291	Iron and Steel	0.0	0.0	0.0	1.0	2.0
304	Metal Stamping, Pressing and Coating	4.0	3.0	3.0	3.0	2.5
306	Hardware, Tool and Cutlery	0.0	0.5	0.0	0.0	0.0
309	Miscellaneous Metal Fabricating	0.0	0.0	0.0	0.0	0.0
315	Machinery and Equipment	1.0	1.0	2.0	2.0	2.0
318	Office and Store Machinery	0.5	2.0	2.0	1.5	1.5
335	Communications Equipment	1.0	0.5	0.5	2.0	2.5
321	Aircraft and Aircraft Parts	3.0	3.0	3.5	4.0	4.0
165	Plastics Fabricating	1.0	1.5	4.5	5.5	5.5
	Services					
701	Chartered Banks	13.0	16.0	18.0	18.5	18.5
701	Trust Companies	15.5	15.0	17.5	21.0	25.0
721	Life Insurance	2.0	3.0	3.0	4.5	5.5
721	General Insurance	10.0	9.5	9.5	9.5	9.5
735	Insurance Brokers	1.5	1.5	1.5	2.5	4.0
909	Federal Government	3.5	3.0	2.5	3.0	2.5
931	Provincial Government	9.0	10.0	9.5	11.0	11.0
951	Local Government	34.0	33.0	34.0	35.0	36.5
544	Telephone Systems	—	—	—	—	—
545	Telegraph and Cable Systems	2.0	2.0	3.0	3.5	3.0
631	Food Stores[1]	50.0	60.0	60.0	60.0	60.0
642	General Merchandise Stores	—	—	—	—	—
853	Computer Services	4.5	7.0	6.0	3.0	2.0
867	Management and Business Consultants	1.5	2.0	3.5	4.5	4.5

[1] Based on expert interviews only.
Source: Appendices 4 and 12

Factors Affecting Employment

Table 4.17 shows factors which were identified by firms as being the most important factors having an impact on their employment levels over the next ten years. Since these are responses to an open-ended question, factors which firms did not voluntarily cite should also be noted. We identify the following:

- Among the Manufacturing industries, broad economic factors such as "Ability to Compete", "Industry-wide Growth" and "Increase Sales and Market Share," were most frequently cited. "Introduction of New Technology" was cited as a distant factor in overall importance.
- Among the Service industries, a wider array of factors were cited reflecting the different nature of the industries contained within this group. The most important factors cited include: "Economic Growth," "Introduction of New Technology," "Industry Growth." "Increase Sales and Market Share," and "Public Policy."
- "Introduction of New Technology" was cited as the single most important factor in four Service industries: Trust Companies, Life Insurance, Telephone Systems, and Telegraph and Cable Systems. In addition, this factor is cited either as second or third order factors in the Chartered Banks, Insurance Broker, General Insurance, the Federal Government, and Computer Services. This factor is therefore more frequently cited as affecting employment among the Service than in the Manufacturing industries.
- Among the Service industries, the three levels of Government all cited "Public Policy" as the most important factor. This identification confirms the different mix of forces affecting activities in these industries, including the effects of political processes which determine the extent and nature of services to be provided.

Table 4.17 **Factors Affecting Employment in Selected Industries in Ontario**

Industry	Factors, Ranked in Descending Order of Importance		
	First	Second	Third
Manufacturing			
291 Iron and Steel	Ability to compete	Availability of necessary skills/Industry-wide growth/Foreign exchange	Introduction of new technology
304 Metal Stamping, Pressing and Coating	Introduction of new technology	Industry-wide growth/ Increase sales or market share	Overall economic growth
306 Hardware, Tool and Cutlery	Industry-wide growth	Availability of necessary skills	Increase sales or market share
309 Miscellaneous Metal Fabricating	Ability to compete	Increase sales or market share	Industry-wide growth
315 Machinery and Equipment	Overall economic growth	Ability to compete	Industry-wide growth
318 Office and Store Machinery	Increase sales or market share	Profitability and financial strength/Overall economic growth	Availability of necessary skills
335 Communications Equipment	Industry-wide growth	Introduction of new technology/Increase sales or market share	Ability to compete
321 Aircraft and Aircraft Parts	Success in foreign markets	Increase sales or market share	Ability to compete
165 Plastics Fabricating	Ability to compete	Product diversification	Introduction of new technology/Profitability and financial strength
Services			
701 Chartered Banks	Overall economic growth	Ability to compete	Introduction of new technology
701 Trust Companies	Introduction of new technology	Overall economic growth/ Industry-wide growth	Profitability and financial strength
721 Life Insurance	Introduction of new technology	Industry-wide growth	Increase sales or market share
721 General Insurance	Industry-wide growth	Overall economic growth/ Introduction of new technology	Ability to compete
735 Insurance Brokers	Increase sales or market share	Introduction of new technology	Profitability and financial strength
909 Federal Government	Public policy	Overall economic growth	Introduction of new technology
931 Provincial Government	Public policy	Overall economic growth	Industry-wide growth
951 Local Government	Public policy	Revenue base	Overall economic growth
544 Telephone Systems	Introduction of new technology	Industry-wide growth	Overall economic growth
545 Telegraph and Cable Systems	Introduction of new technology	Ability to compete/ Increase sales/Industry-wide growth	Foreign markets
631 Food Stores	Increase sales or market share	Collective agreements	Legislation
642 General Merchandise Stores	Increase sales or market share	Legislation	Ability to compete
853 Computer Services	Increase sales or market share	Overall economic growth	Introduction of new technology/Industry-wide growth/Profitability
867 Management and Business Consultants	Overall economic growth	Ability to compete	Industry-wide growth

Source: Appendices 4 and 12

4.3.4 New Technology, Occupations and Skills, 1985-1995

In addition to affecting employment levels, the introduction of new technology affects occupational structures and changes the demand for skills. Accordingly, firms were asked to indicate present and future shares of total employment for major occupational groups in their organizations, including selected occupations which are of special significance because of their employment share or value to the firm.

Firms were also asked to indicate in which occupation they expect to experience an oversupply or shortage of people over the next ten years as a result of the introduction of new technology. In addition, the survey ascertained information on the impact of technology on skill levels of selected occupations over the next decade. Results for changes in occupational distribution, occupational shortage or oversupply, and changing skill levels are presented below.[18]

Occupational Structure

Table 4.18 shows the extent to which industry respondents expect occupational shifts to occur within the selected Manufacturing and Service industries over the next 10 years. The use of the sign "+" indicates that the occupational group is expected to increase its share of total employment; "–" indicates a decline in share; and "0" denotes no change.

- Natural Sciences, Mathematics and Engineering occupations are expected to increase their share of total employment in all selected Manufacturing industries and in most Service industries.
- The pattern for Managerial occupations is more uneven. About equal numbers of industries in the Manufacturing sector indicate an increase or decline in share. In the Service industries, most see an increase, but a few a decline and some foresee no change.
- The pattern also seems uneven for Processing and Fabricating occupations.
- In most selected Manufacturing industries, Machining occupations are expected to increase their share of employment, and Material Handling occupations to decrease their share.
- Clerical occupations are expected to lose in employment share in all selected Service industries with the exception of the Provincial Government and Telegraph and Cable Systems which see no change.

18 Appendices 5–11 and 13–18 contain more detailed occupational information on an industry-specific basis.

Impact of New Technology on Occupations

Table 4.19 presents data concerning potential oversupply or shortages within occupations as perceived by Manufacturing industry representatives. Only those occuptions are listed which were identified by 50 percent or more firms in each industry. The following observations are made:

- Significantly, the list of occupations with a potential shortage in the Manufacturing industries is extensive and consists primarily of managerial, professional, technical and highly-skilled trades personnel.
- In a number of industries, Engineers and Engineering Technicians and Technologists are identified as being occupations in which a shortage is expected.
- On the other hand, the oversupply list is short for the group of selected Manufacturing industries.

Table 4.18 **Changes in Occupational Structure, Selected Industries in Ontario, 1985 to 1995**

Industry	Expected Occupational Employment Trends, 1985–1995							
	Managerial Administrative	Natural Sciences	Clerical	Sales	Processing	Machining	Fabricating Assembly	Material Handling
Manufacturing								
291 Iron and Steel	+	+			–	+	+	+
304 Metal Stamping, Pressing and Coating	+	+			–	+	+	–
306 Hardware, Tool and Cutlery	–	+			+	+	+	–
309 Miscellaneous Metal Fabricating	–	+			+	+	–	–
315 Machinery and Equipment	–	+			–	+	–	–
318 Office and Store Machinery	–	+			N/A	0	+	0
335 Communications Equipment	0	+			0	+	–	–
321 Aircraft and Aircraft Parts	+	+			–	+	–	–
165 Plastics Fabricating	0	+			–	+	–	+
Services Sector								
701 Chartered Banks	+	0	–	N/A				
701 Trust Companies	+	+	–	N/A				
721 Life Insurance	0	+	–	0				
721 General Insurance	+	+	–	+				
735 Insurance Brokers	+	0	–	+				
909 Federal Government	+	+	–	N/A				
931 Provincial Government	–	+	0	N/A				
951 Local Government	+	+	–	N/A				
544 Telephone Systems	0	+	–	+				
545 Telegraph and Cable Systems	0	0	0	+				
631 Food Stores	+	+	–	0				
742 General Merchandise Stores	+	+	–	0				
853 Computer Services	–	+	–	–				
867 Management/Business Consultants	+	0	–	+				

Source: Appendices 4 and 12

Table 4.19 **Impact on Selected Occupations of New Technology in Selected Manufacturing Industries in Ontario, 1985 to 1995**

Industry	Occupations Which 50% or More Firms Identify as Being in: Oversupply	Shortage
291 Iron and Steel	Processing occ. Material Handlers	Managers Engineers Engineering technicians and technologists System analysts Machining and machine tool set-up men Welders and solderers Industrial machinery mechanics and repairmen Electrical equipment installing and repairmen
304 Metal Stamping, Pressing and Coating		
306 Hardware, Tool and Cutlery		Engineering technicians and technologists System analysts Tool and die makers Industrial machinery mechanics and repairmen
309 Miscellaneous Metal Fabricating		Engineering technicians and technologists
315 Machinery and Equipment		Engineering technicians and technologists Systems analysts and computer programmers Tool and die makers Machining and machine tool set-up Machine tool operators Industrial machinery mechanics and repairmen
318 Office and Store Machinery		Engineering technicians and technologists Business and communications machinery mechanics and repairmen
335 Communications Equipment	Electrical equipment fabricators and assemblers Testing and inspecting occ. Material handlers	Managers Fabricating foremen Systems analysts and computer programmers
321 Aircraft and Aircraft Parts		Engineers Processing occ. Machining foremen Tool and die makers Machining and machine tool set-up men Managers Metal shaping and forming occupations
165 Plastics Fabricating		Engineers Engineering technicians and technologists Tool and die makers Machining and machine tool set-up men Supervisors (fabricating)

Source: Data in Appendix 4

Similarly, Table 4.20 presents data concerning potential oversupply or shortages within occupations as perceived by Service industry representatives. Again, only those occupations are listed which were identified by 50 percent or more firms in each industry. The following observations are made:

- The number and range of occupations identified as being in oversupply is much larger in the Service industries than in the Manufacturing industries. The occupations identified in oversupply are almost all Clerical occupations.
- At the same time, a similar number of occupations are identified as likely being in shortage. These occupations are mainly managerial, professional, and technical in nature.
- The array of occupations identified in oversupply and shortage in the Service industries appears to be generally associated with the introduction of new technology.

Table 4.20 **Impact on Selected Occupations of New Technology in Selected Service Industries in Ontario, 1985 to 1995**

Industry		Occupations Which 50% or More Firms Identify as Being in: Oversupply	Shortage
701	Chartered Banks	Typists Bookkeepers and Accounting Clerks General Office Clerks	System Analysts Statistical Clerks Receptionists and Information Clerks
701	Trust Companies	Financial Officers Typists Bookkeepers and Accounting Clerks Finance Clerks EDP Equipment Operators General Office Clerks Cashiers and Tellers	Financial Managers System Analysts Secretaries
721	Life Insurance	Bookkeepers and Clerks EDP Equipment Operators Library File Clerks General Office Clerks	
721	General Insurance	Typists Bookkeeping and Accounting Clerks Insurance Clerks EDP Equipment Operators Library File Clerks General Office Clerks	Financial Managers Financial Officers
735	Insurance Brokers	Secretaries Typists Library File Clerks	System Analysts Bookkeeping and Accounting Clerks EDP Equipment Operators Insurance Salesmen and Agents
909	Federal Government	Clerical Supervisors Secretaries Typists EDP Equipment Operators	Financial Officers
931	Provincial Government	Secretaries Typists EDP Equipment Operators Library File Clerks	Financial Officers Personnel Managers Administrators System Analysts
951	Local Government	Financial Officers Draughtsmen Clerical Supervisors Secretaries Typists Bookkeepers and Accounting Clerks EDP Equipment Operators Library File Clerks General Office Clerks	Personnel Managers Administrators Government Inspectors Engineers System Analysts
544	Telephone Systems		System Analysts
545	Telegraph and Cable Systems	Bookkeepers and Accounting Clerks	Managers Engineering Technicians and Technologists Typists
631	Food Stores		
642	General Merchandise Stores		
853	Computer Services	Bookkeepers	Managers System Analysts
867	Management and Business Consultants		Managers

Source: Data in Appendix 12

Changing Skill Levels

Table 4.21 lists occupations which 50 percent or more firms in the Manufacturing industries under study identified as needing different skills as a result of the introduction of new technology. Respondents were asked to identify occupations which will need greater or less skill requirements for the future; they were also asked whether the new skills would require more or less time to achieve the proficiency; finally, they were asked to indicate occupations which will require more or less knowledge of the companies' operations to perform their daily tasks. Observations can be made as follows:

- The occupations which were identified as requiring more skills are extensive, and include managerial, professional, technical and skilled trades personnel. No occupations were identified by this method of identification as needing fewer skills.
- The time to achieve proficiency will be greater for some occupations such as Engineering Technicians and Technologists, Machining Foremen and Repairers, Installers and Mechanics. Draughtsmen, on the other hand, may need less time to acquire proficiency.

Table 4.21 **Impact on Skill Levels of Selected Occupations of New Technology in Selected Manufacturing Industries in Ontario, 1985 to 1995**

Occupations Which 50% or More Firms Identify as Needing:					
Skills		**Time to Achieve Proficiency**		**Knowledge of Firms' Operations**	
More	**Less**	**More**	**Less**	**More**	**Less**
Managers				Managers	
Engineers				Engineers	
Engineering Technicians and Technologists		Engineering Technicians and Technologists	Draughtsmen	Engineering Technicians and Technologists	
Systems Analysts and Computer Programmers				Systems Analysts and Computer Programmers	
Processing Occupations					
Machining Foremen		Machining Foremen		Machining Foremen	
Machinists and Machine Tool Set-Up Men					
Fabricating, Assembling and Repairing Foremen				Fabricating, Assembling and Repairing Foremen	
Electrical Equipment Fabricators and Assemblers					
Electronic Equipment Fabricators and Assemblers					
Electrical Equipment Installers and Repairers		Electrical Equipment Installers and Repairers		Electrical Equipment Installers and Repairers	
Industrial Machinery Mechanics and Repairmen		Industrial Machinery Mechanics and Repairmen			
Fabricating and Assembling Inspectors and Testers				Fabricating and Assembling Inspectors and Testers	

Source: Data in Appendix 4

Table 4.22 identifies occupations which 50 percent or more firms in the selected Service industries indicated will need different skills as the result of the introduction of new technology. The following observations are made:

- No occupations were identified as needing fewer skills for the 1985-1995 period.
- A substantial number of occupations were identified as needing more skills, more time being necessary to achieve the required proficiency, and as needing more knowledge of firms' operations.
- Among those occupations needing more skills are a broad array of occupational groups including Managers, Engineers, System Analysts, Clerical Supervisors, Secretaries, and a range of Clerks.

Table 4.22 **Impact on Skill Levels of Selected Occupations of New Technology in Selected Service Industries in Ontario, 1985 to 1995**

Occupations Which 50% or More Firms Identify as Needing:					
Skills		**Time to Achieve Proficiency**		**Knowledge of Firms' Operations**	
More	**Less**	**More**	**Less**	**More**	**Less**
Managers				Managers	
Financial Managers		Financial Managers		Financial Managers	
Personnel Officers		Personnel Officers		Personnel Officers	
Government Administrators		Government Administrators		Government Administrators	
Government Inspectors				Government Inspectors	
Electrical Engineers					
Scientists		Scientists			
Engineers					
Engineering Technicians and Technologists					
Draughtsmen					
System Analysts		System Analysts		System Analysts	
Clerical Supervisors		Clerical Supervisors		Clerical Supervisors	
Statistical Clerks					
Insurance Clerks		Insurance Clerks		Insurance Clerks	
Library File Clerks					
Claim Adjusters				Claim Adjusters	
Office Clerks					
Secretaries					
Typist/Clerk Typist (including Word Processors)					
Bookkeepers and Accounting Clerks					
EDP Equipment Operators					
Stock Clerks		Stock Clerks			
Receptionist/ Information Clerks		Receptionist/ Information Clerks			
Sales Supervisors		Sales Supervisors		Sales Supervisors	
Insurance Salesmen		Insurance Salesmen		Insurance Salesmen	

Source: Data in Appendix 12

4.3.5 Steps Firms Will Take Regarding Change, 1985-1995

Oversupply of Skills

In addition to identifying those occupations which are expected to experience an oversupply or shortage of skills, firms were asked about steps they would likely take to deal with these situations.

In this connection, firms were asked to identify the steps they would likely take to deal with an oversupply of skills within their organization over the next ten years.

Table 4.23 presents the most likely steps firms in the Manufacturing and Service industries would take to deal with an oversupply of skills. The following responses were observed:

- "Attrition" and "Retraining" were the most commonly cited steps Manufacturing industries indicated they would take.
- In the Service industries, "Attrition" was overwhelmingly cited by most industries as the step they would take to deal with oversupply situations. "Retraining" was the second most common step cited. Other responses included "Layoffs," "Upgrading," and "Job Sharing/Shorter Hours."
- "Lay-offs" were not seen as a preferred option for dealing with oversupply situations.

Table 4.23 **Most Likely Steps Firms Will Take to Deal With Oversupply of Skills* in Ontario, 1985 to 1995**

	Most Commonly Cited	Second Most Common	Third Most Common
Manufacturing Industries			
Processing Occupations	Attrition	Retraining	Lay-offs
Electronic Equipment Fabricators and Assemblers	Retraining	Attrition	Lay-offs
Testers and Inspectors	Retraining	Upgrading	Lay-offs
Material Handlers	Attrition	Retraining	Transfer/ Relocation
Service Industries			
Financial Officers	Attrition	Retraining	Lay-offs
Draughtsmen	Attrition	Retraining	—
Clerical Supervisors	Attrition	Retraining	Lay-offs
Secretaries	Attrition	Retraining	Upgrading
Typists	Attrition	Retraining	Shorter Hours/ Job Sharing
Bookkeepers and Accounting Clerks	Attrition	Retraining	Lay-offs
Finance Clerks	Job-sharing	Lay-offs	—
Insurance Clerks	Attrition	—	—
EDP Equipment Operators	Attrition	Retraining	Upgrading
Library File Clerks	Attrition	Retraining	Upgrading
General Office Clerks	Attrition	Retraining	Shorter Hours
Cashiers and Tellers	Attrition	Upgrading	Lay-offs

*Occupations selected are those which 50% or more firms in any industry identified as being in oversupply. See Tables 4.20 and 4.19.

Source: Special tabulation of data in Appendices 4 and 12

Shortage of Skills

Table 4.24 presents the steps industries would take to deal with the shortage of skills they expect over the next ten years.

- "Recruitment" is the most commonly cited step Manufacturing industries expect to take for managerial and professional personnel, followed closely by "Retraining" for skilled trades occupations.
- In the Service industries, "Retraining" is the most commonly cited first step for a variety of Clerical and Managerial personnel. For highly skilled technical and professional occupations the most common step cited was "Recruitment" of new personnel.

Table 4.24 **Most Likely Steps Firms Will Take to Deal With Shortage of Skills* in Ontario, 1985 to 1995**

	Most Commonly Cited	Second Most Common	Third Most Common
Manufacturing Industries			
Managers	Recruit	Upgrade	Retrain
Engineers	Recruit	Retrain	Contract
Engineering Technicians and Technologists	Recruit	Retrain	Upgrade
Draughtsmen	Recruit	Retrain	—
System Analysts	Recruit	Retrain	Contract
Processing Occupations	Recruit	Retrain	Upgrade
Tool and Die Makers	Recruit	Retrain	Contract
Machinists and Machine Tool Set-Up Men	Recruit	Retrain	Upgrade
Machine Tool Operators	Retrain	Recruit	Upgrade
Metal Shapers and Formers	Retrain	Recruit	—
Welders and Solderers	Retrain	Recruit	Upgrade
Fabricating Supervisors	Retrain	Upgrade	Recruit
Electrical Equipment Installers and Repairers	Retrain	Recruit	—
Industrial Machinery Installers and Repairers	Retrain	Recruit	—
Service Industries			
Managers	Retrain	Upgrade	Recruit
Financial Officers	Retrain	Recruit	Upgrade
Government Administrators	Retrain	Upgrade	—
Government Inspectors	Retrain	Upgrade	—
Engineers	Recruit	—	—
Engineering Technicians and Technologists	Recruit	Retrain	Upgrade
System Analysts	Recruit	Retrain	—
Secretaries	Retrain	Recruit	Upgrade
Statistical Clerks	Retrain	Recruit	—
Insurance Salesmen	Recruit	—	—

*Occupations selected are those which 50% or more firms in any industry identified as being in shortage. See Table 4.19 and Table 4.20.

Source: Special tabulation of data in Appendices 4 and 12

Training Costs

Table 4.25 presents results on training costs within selected Manufacturing and Service industries. Results are presented on firms' total training costs as a percent of total labour costs for past and future periods. Results are also presented on the percent of training costs related to new technology. The following may be observed:

- For the Iron and Steel Industry, the Metal Stamping, Pressing and Coating Industry, and the Machinery and Equipment Industry, training costs as a percent of total labour costs, have been generally low, in the area of 2 percent. Other industries indicated somewhat higher training costs for the past few years, with much higher costs cited by the Office and Store Machinery Industry and the Aircraft and Aircraft Parts Industry.
- In the Service industries, training costs as a percent of labour costs have generally been in the range of 2 to 5 percent with Telephone Systems and Computer Services having had much higher expenditures in recent years, in the range of over 10 percent.
- With regard to the future, training costs as a percentage of labour costs are seen as generally increasing, but with some industries continuing to show low proportionate training costs in comparison to other industries.
- The percent of training costs related to new technology ranged from 10 percent to 80 percent for different Manufacturing industries during the past few years. The Iron and Steel industry indicated a very high percentage of training costs related to the introduction of new technology, as did the Aircraft and Aircraft Parts Industry. If one observes the data for 1985 only, most industries indicated 30 percent or more of training costs as being related to new technology.
- In the Service industries, training costs related to new technology ranged from 10 to 100 percent over the past few years. High training costs related to new technology were particularly cited by the Telephone Systems Industry, and the Life Insurance Industry.
- With respect to the future, responses suggest the proportion of training costs related to the introduction of new technology in the next ten years is not likely to change significantly from the present for most industries.

4.3.6 Context of Worker/ Management Relationships, 1985-1995

The context in which new technology is adopted in the workplace is important in determining effects on productivity. In this section, results from the survey are presented which indicate the extent of union representation in the industries surveyed, and the number and type of collective agreements with technology change clauses. Data are also presented which indicate the extent to which workers are involved in the decision-making processes of technological change.

Table 4.25 **Training Costs in Selected Industries in Ontario, 1981 to 1995**

Industry	Training Costs as a Percent of Labour Costs					Percent of Training Costs Related to New Technology				
	Estimated			Expected		Estimated			Expected	
	1981	1984	1985	1990	1995	1981	1984	1985	1990	1995
Manufacturing										
291 Iron and Steel	—	2.0	2.0	2.5	2.5	60	80	60	75	75
304 Metal Stamping, Pressing and Coating	—	2.0	1.5	2.0	2.0	15	20	25	30	30
306 Hardware, Tool and Cutlery	—	5.0	5.5	6.0	6.5	10	40	50	55	55
309 Miscellaneous Metal Fabricating	—	5.0	4.5	5.0	5.0	15	25	35	30	30
315 Machinery and Equipment	—	2.0	2.0	2.0	2.5	10	10	15	20	20
318 Office and Store Machinery	—	5.5	6.0	8.5	9.5	40	40	45	50	50
335 Communications Equipment	—	2.5	3.0	4.0	4.0	35	30	35	35	40
321 Aircraft and Aircraft Parts	—	4.0	6.0	7.0	7.5	50	55	60	65	65
165 Plastics Fabricating	—	3.0	5.5	6.0	6.0	25	40	45	55	55
Services										
701 Chartered Banks	2.0	2.5	2.5	2.0	2.0	25	20	30	40	40
701 Trust Companies	0.5	3.0	3.5	4.0	4.0	10	30	35	45	45
721 Life Insurance	4.5	5.0	5.5	7.0	7.0	40	60	60	60	65
721 General Insurance	2.5	3.0	4.0	4.5	5.0	25	25	40	45	40
735 Insurance Brokers	1.0	1.5	2.0	2.5	3.0	25	35	35	35	35
909 Federal Government	3.0	2.5	3.0	4.0	4.0	25	30	30	40	45
931 Provincial Government	1.5	1.5	2.0	1.5	1.5	30	35	40	50	50
951 Local Government	1.5	2.0	2.0	3.0	4.5	30	45	45	55	55
544 Telephone Systems	6.0	10.0	13.5	9.0	9.0	100	85	85	75	75
545 Telegraph and Cable Systems	—	—	—	—	—	—	—	—	—	—
631 Food Stores[1]	1.0	1.0	1.0	1.5	1.5	20	20	20	35	35
642 General Merchandise Stores	—	—	—	—	—	—	—	—	—	—
853 Computer Services	3.0	11.5	12.5	10.0	10.0	35	55	55	55	55
867 Management and Business Consultants	3.0	4.0	4.0	4.0	4.0	30	45	50	45	45

[1] Based on expert interviews.

Source: Appendices 4 and 12

Union Representation

Table 4.26 shows the extent of firms within the sample of selected Manufacturing and Service industries which have union representation. It also shows the proportion of employment that is unionized among those firms with a union.

- In general, higher proportions of industries in the Manufacturing sector have union representation as compared to the Service sector.
- At present, over 50 percent of employment in most of the selected Manufacturing industries with a union is unionized. The exceptions to this are the Office and Store Machinery Industry and the Machinery and Equipment Industry.
- A small percentage of employees in the Finance and Insurance Industries are unionized, but a high proportion are unionized in the Public Administration and Food Stores Industries.
- Some Manufacturing industries indicate a decline in the share of employment which they expect will be unionized by 1990 and 1995, although the decline is rather small. Little change is expected for the Service industries.

Table 4.26 **Union Representation in Selected Industries in Ontario, 1984 to 1995**

Industry	Percent of Firms with Union Representation	Percent of Employment Unionized in Firms with Unions			
		Estimated		Expected	
		1984	1985	1990	1995
Manufacturing					
291 Iron and Steel	35	80	80	75	70
304 Metal Stamping, Pressing and Coating	40	75	80	75	75
306 Hardware, Tool and Cutlery	20	65	60	60	60
309 Miscellaneous Metal Fabricating	65	65	65	65	65
315 Machinery and Equipment	60	45	35	35	35
318 Office and Store Machinery	25	20	20	15	15
335 Communications Equipment	25	65	65	65	65
321 Aircraft and Aircraft Parts	65	80	80	75	75
165 Plastics Fabricating	55	80	80	80	80
Services					
701 Chartered Banks	25	5	5	5	5
701 Trust Companies	30	5	5	5	5
721 Life Insurance	0	—	—	—	—
721 General Insurance	0	—	—	—	—
735 Insurance Brokers	5	15	15	10	15
909 Federal Government	100	85	85	85	85
931 Provincial Government	100	80	80	80	80
951 Local Government	100	85	85	85	85
544 Telephone Systems	20	—	—	—	—
545 Telegraph and Cable Systems	100	40	45	50	50
631 Food Stores[1]	65	90	90	90	90
642 General Merchandise Stores	—	—	—	—	—
853 Computer Services	0	—	—	—	—
867 Management and Business Consultants	0	—	—	—	—

[1] Based on expert interviews.
Source: Appendices 4 and 12

Unions and Technological Change

Data on the extent of employment contracts with a technology change clause, and the types of clauses covered, are presented in Table 4.27. The results are as follows:

- Of the firms with employment contracts, 80 percent within the Iron and Steel Industry had contracts with technology change clauses. All of these provide for advance notice, and most for job security, and seniority.
- The percent of firms with technology change clauses is somewhat lower in the Metal Stamping, Pressing and Coating Industry, the Communications Equipment Industry, and the Aircraft and Aircraft Parts Industry, and much lower in all other industries.
- In the Service sector, collective agreements in the Telegraph and Cable industry and in Public Administration generally contain clauses covering "Advance Notice," "Consultation," "Job Security," "Joint Committees," and "Seniority." Other industries have less extensive coverage or no coverage.
- "Advance Notice" is the most frequent clause in all manufacturing agreements with a technology change clause, followed by "Consultation," "Seniority," and "Job Security."
- Joint-technological change committees are cited by the following industries: Aircraft and Aircraft Parts, Chartered Banks, Public Administration, and Telegraph and Cable Systems.
- Management of most industries which have technology change clauses in their firms' collective agreements believe the clauses are being effectively administered. The extent of comparable survey data from unions is small but suggests a different perspective, with union respondents in the Manufacturing industries saying that the clauses were not effectively administered.

Table 4.27 **Unions and Technological Change in Selected Industries in Ontario**

Industry	Percent of Firms With a Union	Percent of Contracts With a Technology Change Clause	Percent of Technology Change Clauses Covering					
			Notice	Consult	Job Security	Joint Committee	Seniority	Other
Manufacturing								
291 Iron and Steel	35	80	100	75	75	0	75	0
304 Metal Stamping, Pressing and Coating	35	65	40	40	0	0	0	20
306 Hardware, Tool and Cutlery	20	20	100	0	0	0	0	100
309 Miscellaneous Metal Fabricating	65	25	0	0	0	0	50	50
315 Machinery and Equipment	60	25	100	65	65	0	65	0
318 Office and Store Machinery	25	0	—	—	—	—	—	—
335 Communications Equipment	25	50	60	20	0	0	20	0
321 Aircraft and Aircraft Parts	65	60	90	45	45	65	55	10
165 Plastics Fabricating	60	35	65	35	65	0	100	35
Services								
701 Chartered Banks	25	75	100	100	0	100	65	35
701 Trust Companies	30	0	—	—	—	—	—	—
721 Life Insurance	0	0	—	—	—	—	—	—
721 General Insurance	0	0	—	—	—	—	—	—
735 Insurance Brokers	5	0	—	—	—	—	—	—
909 Federal Government	100	80	55	75	55	30	0	5
931 Provincial Government	100	90	80	80	80	45	45	20
951 Local Government	100	65	45	45	55	10	50	40
544 Telephone Systems	20	100	100	65	35	0	35	35
545 Telegraph and Cable Systems	100	100	50	65	85	50	100	50
631 Food Stores	65	—	—	—	—	—	—	—
642 General Merchandise Stores	—	—	—	—	—	—	—	—
853 Computer Services	0	—	—	—	—	—	—	—
867 Management and Business Consultants	0	—	—	—	—	—	—	—

Source: Appendices 4 and 12

Worker Involvement in the Process of Technological Change

Table 4.28 provides information on worker involvement in the process of technological change. Specifically, information is presented regarding the percent of firms which management respondents indicated have a formal mechanism for worker participation in setting production and sales targets, in improving the quality of productivity, and in the adoption of new technology. As may be observed:

- A significant proportion of firms within each industry identify the existence of formal mechanisms for worker participation in improving productivity and product quality.
- The existence of formal mechanisms for worker involvement in the adoption of new technology varies across Manufacturing industries with the Iron and Steel Industry and the Office and Store Machinery Industry being in the lead, followed by the Hardware, Tool and Cutlery Industry. The proportion of firms in all other industries with such a mechanism declines thereafter.
- In the Service industries, a large percentage of departments surveyed within the Federal Government indicate the existence of a formal mechanism dealing with the adoption of new technology. Fifty percent or more of firms in the Insurance Brokers, Computer Services, Management and Business Consulting, and Telephone Systems Industries indicate the existence of such a mechanism.

Table 4.28 Worker Involvement in the Process of Technological Change

Industry		Percent of Firms with a Formal Mechanism for Worker Participation In:*					
		Setting Production or Sales Targets					
		At Company Level	At Plant Level	At Department Level	At Working Group Level	Improving Productivity/ Quality	Adoption of New Technology
Manufacturing							
291	Iron and Steel	0	0	0	65	100	65
304	Metal Stamping, Pressing and Coating	5	20	50	60	65	20
306	Hardware, Tool and Cutlery	30	30	50	70	90	50
309	Miscellaneous Metal Fabricating	5	25	20	0	40	25
315	Machinery and Equipment	0	0	0	30	40	30
318	Office and Store Machinery	55	50	65	50	80	65
335	Communications Equipment	15	15	20	25	55	5
321	Aircraft and Aircraft Parts	15	10	20	20	50	40
165	Plastics Fabricating	25	30	40	30	70	35
Services							
701	Chartered Banks	15	20	70	50	35	25
701	Trust Companies	60	60	40	50	70	40
721	Life Insurance	50	40	70	40	75	35
721	General Insurance	25	20	40	40	45	10
735	Insurance Brokers	65	80	80	80	80	55
909	Federal Government	25	20	20	40	55	85
931	Provincial Government	10	0	0	0	35	35
951	Local Government	0	20	0	0	50	30
544	Telephone Systems	50	40	40	60	60	55
545	Telegraph and Cable Systems	0	0	0	50	75	0
631	Food Stores[1]	0	0	0	0	0	0
642	General Merchandise Stores	—	—	—	—	—	—
853	Computer Services	25	35	50	40	60	60
867	Management and Business Consultants	10	20	70	35	70	50

*Multiple Responses Included.
[1] Based on expert interviews.
Source: Appendices 4 and 12

Table 4.29 **Management's Perception of Appropriate Roles for Workers in Decision-Making Regarding New Technology**

Industry	Percent of Firms Identifying These Roles as Appropriate for Workers*							
	No Involvement	Information Only	Advance Notice	Explanation Re Job Security	Discussion (Limited Dialogue)	Prior Consultation	Explanation/ Set-up of Training	Full Involvement
Manufacturing								
291 Iron and Steel	35	65	0	0	0	0	35	35
304 Metal Stamping, Pressing and Coating	30	10	0	10	5	30	5	20
306 Hardware, Tool and Cutlery	5	40	0	5	20	25	0	20
309 Miscellaneous Metal Fabricating	30	15	0	15	0	0	0	35
315 Machinery and Equipment	25	0	0	0	0	65	15	15
318 Office and Store Machinery	0	25	25	0	0	40	0	30
335 Communications Equipment	55	25	0	15	5	20	5	5
321 Aircraft and Aircraft Parts	10	0	0	10	10	45	25	10
165 Plastics Fabricating	5	40	30	15	35	15	15	25
Services								
701 Chartered Banks	25	15	0	25	0	15	0	60
701 Trust Companies	15	0	0	30	0	10	0	45
721 Life Insurance	0	0	0	0	40	20	20	60
721 General Insurance	0	15	0	15	15	0	0	60
735 Insurance Brokers	30	60	0	30	0	30	0	15
909 Federal Government	0	20	15	0	15	40	0	25
931 Provincial Government	15	20	0	20	25	55	25	0
951 Local Government	10	25	10	10	10	20	0	30
544 Telephone Systems	40	20	0	20	20	60	20	0
545 Telegraph and Cable Systems	50	50	0	0	0	50	0	0
631 Food Stores	—	—	—	—	—	—	—	—
642 General Merchandise Stores	—	—	—	—	—	—	—	—
853 Computer Services	0	0	25	0	25	25	50	25
867 Management and Business Consultants	0	40	0	0	0	0	50	10

*Multiple Responses Included. See cautionary note in source.
Source: Appendices 4 and 12

The response of management and unions to the existence of formal mechanisms may be compared across all Manufacturing industries. This information is not presented in a table because the union response was not fully representative of the industries surveyed. While almost 40 percent of managers in all Manufacturing industries indicated they had a formal mechanism for worker participation in the adoption of new technology, only about 20 percent of union respondents indicated the existence of such a mechanism. This suggests differences of interpretation regarding what constitutes a formal mechanism.

Table 4.29 presents the results of an open-ended question regarding management's view of the role which workers should have in decision-making regarding new technology.

- There is a broad spectrum of management views within firms and within industries regarding how workers should be involved in decisions on adopting new technology. Approximately 20 percent of respondents feel workers should have "Full Involvement;" conversely, about 20 percent feel they should have "No Involvement." The most frequent roles identified were "Information Only," and "Prior Consultation."

Planning for Technological Change

Table 4.30 shows the time-horizon and the types of plans which firms utilize in order to plan for technological change. Some highlights are:

- A significant proportion of firms in all industries indicate the existence of a strategic plan; in most industries a slightly lower proportion have a capital investment plan. The average planning horizon for the latter is four to five years.
- A somewhat lower proportion of firms in most industries indicate the existence of a human resource plan, although 60 percent or more of firms in the following industries indicated that they have a plan: Iron and Steel, Office and Store Machinery, Plastics Fabricating, Chartered Banks, General Insurance, Insurance Brokers, Provincial Government, and Telegraph and Cable Systems. The average time horizon for human resource planning is four to five years.
- In general, most industries acknowledged a modest level of integration between capital and human resource plans.

In our surveys of selected industries, both management and union respondents were asked what was the union's position regarding the adoption of new technology. When results are compared across industries, the management and union responses to this question are remarkably similar: a high percentage of both management and union respondents see unions as accepting new technology. Management sees job security and retraining as the chief concerns of the union. Similarly, among union respondents, job security and training were also the most frequently mentioned concerns.

Table 4.30 **Planning for Technological Change in Selected Industries in Ontario**

Industry		Strategic Plan	Human Resource Plan		Capital Investment Plan		Perceived Integration Between Capital And Human Plans*
		Percent of Firms with Plan	Percent of Firms with Plan	Planning Horizon (Years)	Percent of Firms with Plan	Planning Horizon (Years)	
Manufacturing							
291	Iron and Steel	100	65	5	100	5	4
304	Metal Stamping, Pressing and Coating	70	25	4	60	4	2
306	Hardware, Tool and Cutlery	50	50	4	65	4	4
309	Miscellaneous Metal Fabricating	70	7	3	30	2	1
315	Machinery and Equipment	60	40	5	55	5	2
318	Office and Store Machinery	60	60	5	35	3	3
335	Communications Equipment	60	35	5	50	4	3
321	Aircraft and Aircraft Parts	55	40	4	50	4	3
165	Plastics Fabricating	45	60	3	60	4	3
Services							
701	Chartered Banks	100	90	6	70	4	4
701	Trust Companies	75	55	5	25	6	5
721	Life Insurance	80	50	4	30	6	2
721	General Insurance	75	70	6	60	5	3
735	Insurance Brokers	45	60	5	40	5	3
909	Federal Government	85	85	4	85	5	2
931	Provincial Government	70	55	4	55	4	3
951	Local Government	20	40	5	40	5	1
544	Telephone Systems	65	20	6	35	7	3
545	Telegraph and Cable Systems	100	100	7	100	14	4
631	Food Stores	—	—	—	—	—	—
642	General Merchandise Stores	—	—	—	—	—	—
853	Computer Services	40	40	4	20	5	5
867	Management and Business Consultants	80	55	4	25	4	4

***NOTE** 5 means high level of integration, 1 means low.
Source: Appendices 4 and 12

CHAPTER 5 5 5 5

Employment and New Technology, 1985 to 1995: Industry-Sector Studies

Chapter Contents

The Task Force's research agenda was designed to examine the impact of technological change on employment at different levels of aggregation in the economy, including the levels of the firm and industry, the industry-sector, and the overall economy. In Chapter 4, we have reviewed the likely employment effects of new technology for selected industries in Ontario. In this chapter we observe effects of the process of technological change at the industry-sector level for all industry-sectors in Ontario, and by so doing we establish a complete view of the extent and nature of likely employment effects for 1985-1995 to complement our examination of selected industries.

5.1 Introduction

In this chapter we describe likely patterns of employment change for all industry-sectors in Ontario for the period 1985-1995. We examine employment levels, employment growth, occupational distributions, occupational employment levels, and occupational growth patterns for all industry-sectors. Also, in order to establish perspective, we make comparisons of the patterns for employment change estimated for 1985-1995 to those which actually occurred in the recently past decade, 1971-1981, which we have described in Chapter 2.

We recognize there are always risks to making quantitative estimates for the future, and that no one can say with absolute certainty what employment patterns will unfold for the future. Accordingly, what we have chosen to do is to gather information from a wide variety of knowledgeable sources which describes, at this point in time, their expectations for likely directions and magnitudes of employment-related changes. This has been accomplished by an orderly process which is documented in Appendix 19. While we are aware of further improvements which could be made to this process, we feel it is already an advance on existing methodologies since it draws from a consultation process with a wide cross-section of knowledgeable sources, and explicitly deals with future occupational changes related to technological change.

In this chapter, we proceed as follows:

- First, we describe the methodology used for estimating employment levels for each industry-sector, and the results obtained. We have grouped total Ontario employment into 23 industry-sectors and for each we have gathered estimates of future employment levels.
- Second, we describe the methodology for estimating occupational compositions, and the results obtained. We have made estimates of future occupational compositions for all 23 industry-sectors, utilizing Labour Force Survey and Census data, and findings from our own industry studies. This provides an important linkage to technological change since as industries adopt new technology the changing nature of work-tasks results in measurable occupational trends.
- Third, data regarding industry-sector employment are then brought together with

the occupational compositions to produce estimates of future occupational employment levels.

- Finally, in order to establish a perspective on estimates for 1985-1995, comparisons are made with similar historical data for the 1971-1981 period.

Table 5.1 **Employment and Employment Growth by Industry-Sector in Ontario, 1985 to 1995**

Industry-Sector	Expected Employment (000) 1985	Expected Employment (000) 1995	Employment Growth (000) 1985–1995
Community, Business and Personal Services	1,340	1,725	385
Trade	685	795	110
Construction	208	237	29
Transportation and Storage	157	183	26
Public Administration	270	295	25
Primary Metal and Metal Fabricating	152	176	24
Finance, Insurance and Real Estate	253	275	22
Communication	95	113	18
Machinery and Other Transportation Equipment	90	105	15
Paper and Allied Industries	118	130	12
Electrical Products	90	102	12
Other Manufacturing Industries	61	73	12
Food, Feed, Beverage and Tobacco	97	108	11
Wood and Furniture	58	67	9
Chemical, Rubber and Petroleum	104	112	8
Electric Power and Gas Utilities	46	54	8
Motor Vehicles and Parts	102	108	6
Other Mines and Quarries	38	42	4
Agriculture, Fishing and Trapping	137	140	3
Forestry	11	13	2
Non-metallic Mineral Products	27	29	2
Mineral Fuel Mines and Wells	2	2	0
Textile and Clothing	70	70	0
All Industries	4,211	4,954	743

Source: Appendix 19

5.2 Industry-Sector Employment, 1985-1995

We have conducted a survey to gather industry-sector employment estimates for the 1985-1995 period from a wide range of well-informed sources. About two dozen organizations and industry experts participated in this survey. Data were gathered from major banks, investment houses, economic research organizations, government agencies and departments, crown corporations, and industry associations. Approximately ten to twelve employment estimates were received for each of the 23 industry-sectors for the period 1985-1995. In addition, we have used employment estimates resulting from our industry studies, as described in the previous chapter, to the extent possible in relevant industry-sectors. We have assumed that each estimate has an equal probability of being the 'correct' estimate, and therefore that all estimates should be equally used in determining an employment projection for each industry-sector. Accordingly, using all estimates, median employment estimates were established for each of the 23 industry-sectors. The results we present in this section are based on these median estimates. In addition, since it soon became clear that special attention was warranted, we also conducted a special survey of sub-groups within the Community, Business and Personal Services sector.

The results of these activities are summarized in Tables 5.1 and 5.2, and Figures 5.1, 5.2, and 5.3. We have identified the following patterns in these results.

5.2.1 About 75,000 New Jobs are Expected to be Created Each Year over the Next Ten Years

The aggregation of median employment estimates for all 23 industry-sectors indicates that total employment in Ontario is expected to increase by about 750,000 persons over the 1985-1995 period, thus suggesting the annual creation of new job additions will be approximately 75,000 per year.

When the projected total employment growth over the next decade is broken down into two five-year periods, employment growth between 1985 and 1990 is expected to increase by 336,000, compared with 407,000 for the 1990-1995 period.

5.2.2 Most New Jobs are Expected to Come from Service-Related Industries

The goods-producing industries are expected to create about 20 percent of the new jobs while services-producing industries are expected to generate about 80 percent of all new jobs over the next decade.

Among contributors to employment growth, the Community, Business and Personal Services sector is expected to be the leading contributor (52 percent), followed by the Trade sector (15 percent).

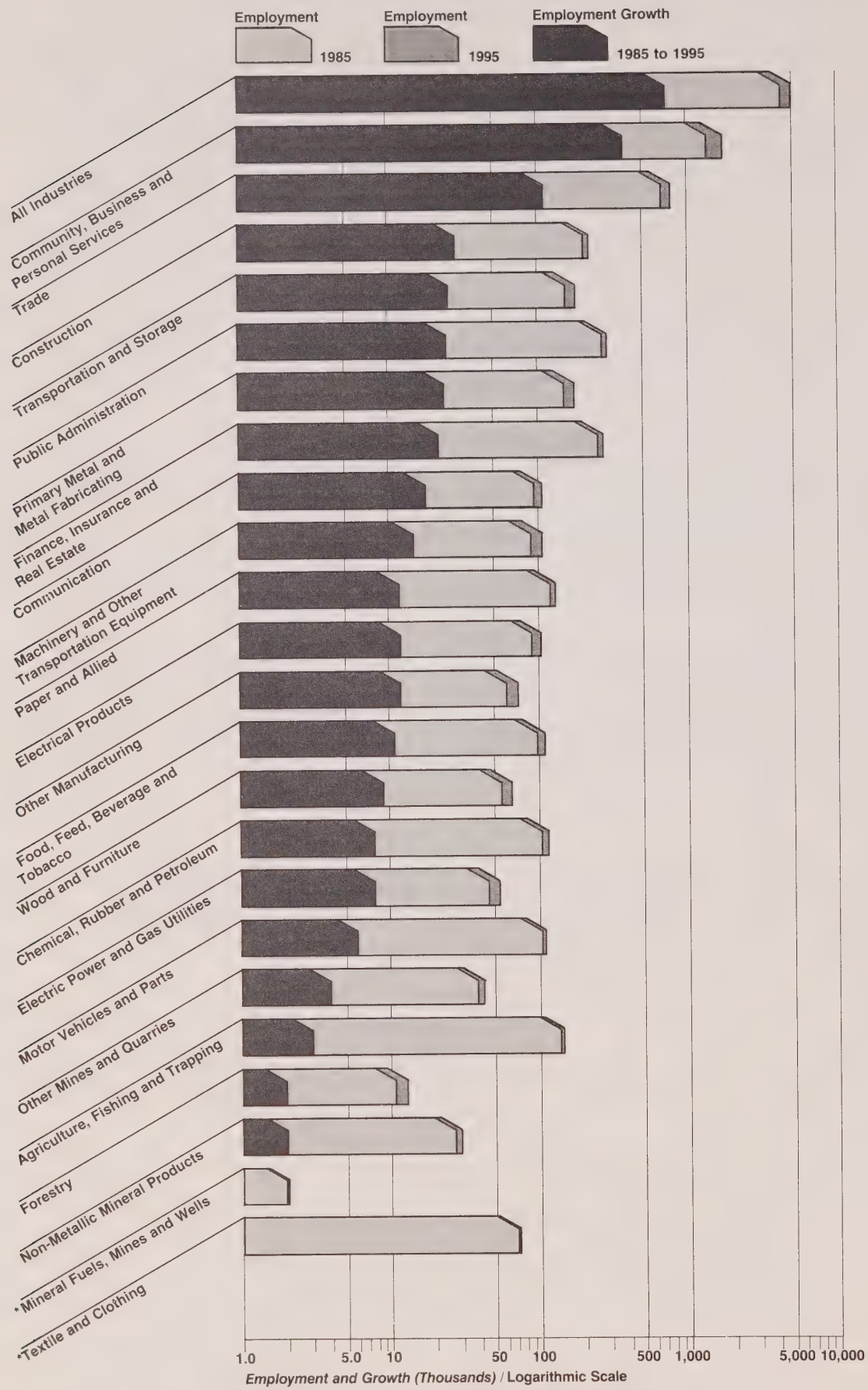
Table 5.2 **Employment and Employment Growth in the Community, Business and Personal Services Industry-Sector in Ontario, 1985 to 1995**

Industry-Sector Sub-Group	Expected Employment (000) 1985	Expected Employment (000) 1995	Employment Growth (000) 1985-1995	% of Total Growth
Services to Business Management	224	412	188	42
Accommodation and Food Services	276	414	138	31
Health and Welfare Services	282	335	52	12
Amusement and Recreation Services	65	116	51	11
Miscellaneous Services	89	99	9	2
Education and Related Services	278	282	4	1
Religious Organizations	21	24	2	1
Personal Services	70	71	1	0
Total	1,306	1,751	444	100

Source: Appendix 19, Special Survey Results

Figure 5.1

Employment and Employment Growth by Industry-Sector in Ontario, 1985 to 1995



*No change 1985 to 1995

NOTE Bars are one behind another with the smallest at the front.
Source: Appendix 19

5.2.3 Seven Industry-Sectors are Expected to Account for Most of the New Jobs

Seven industry-sectors are expected to account for about 84 percent of the projected total employment increase. These sectors are:

- Community, Business and Personal Services (52 percent of growth)
- Trade (15 percent of growth)
- Construction (4 percent of growth)
- Transportation and Storage (4 percent of growth)
- Public Administration (3 percent of growth)
- Primary Metal and Metal Fabricating (3 percent of growth)
- Finance, Insurance and Real Estate (3 percent of growth)

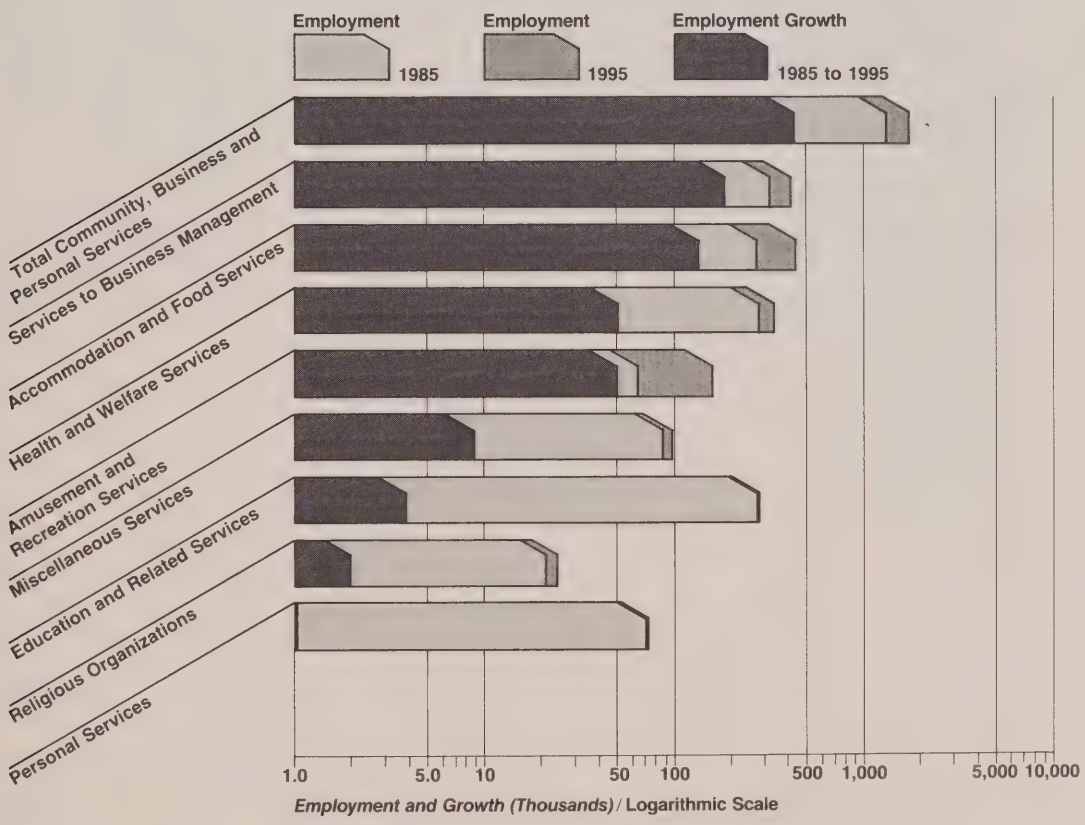
Conversely, industry-sectors which are expected to have little or no employment growth over the next decade include: Textile and Clothing; Forestry; Mineral Fuel Mines and Wells; Non-Metallic Mineral Products; and Agriculture, Fishing and Trapping.

5.2.4 Employment Growth in the Community, Business and Personal Services Sector

The Community, Business and Personal Services industry-sector contains industry sub-groups which individually are major employers. For example, Table 5.2 shows major sub-groups of the sector to be Services to Business Management, Accommodation and Food Services, Health and Welfare Services, and Education and Related Services. With the exception of Education and Related Services, employment growth over 1985-1995 is foreseen for each of these sub-groups. Services to Business Management, Accommodation and Food Services, and Amusement and Recreation Services are expected to contribute significantly to employment growth over the next decade.

Figure 5.2

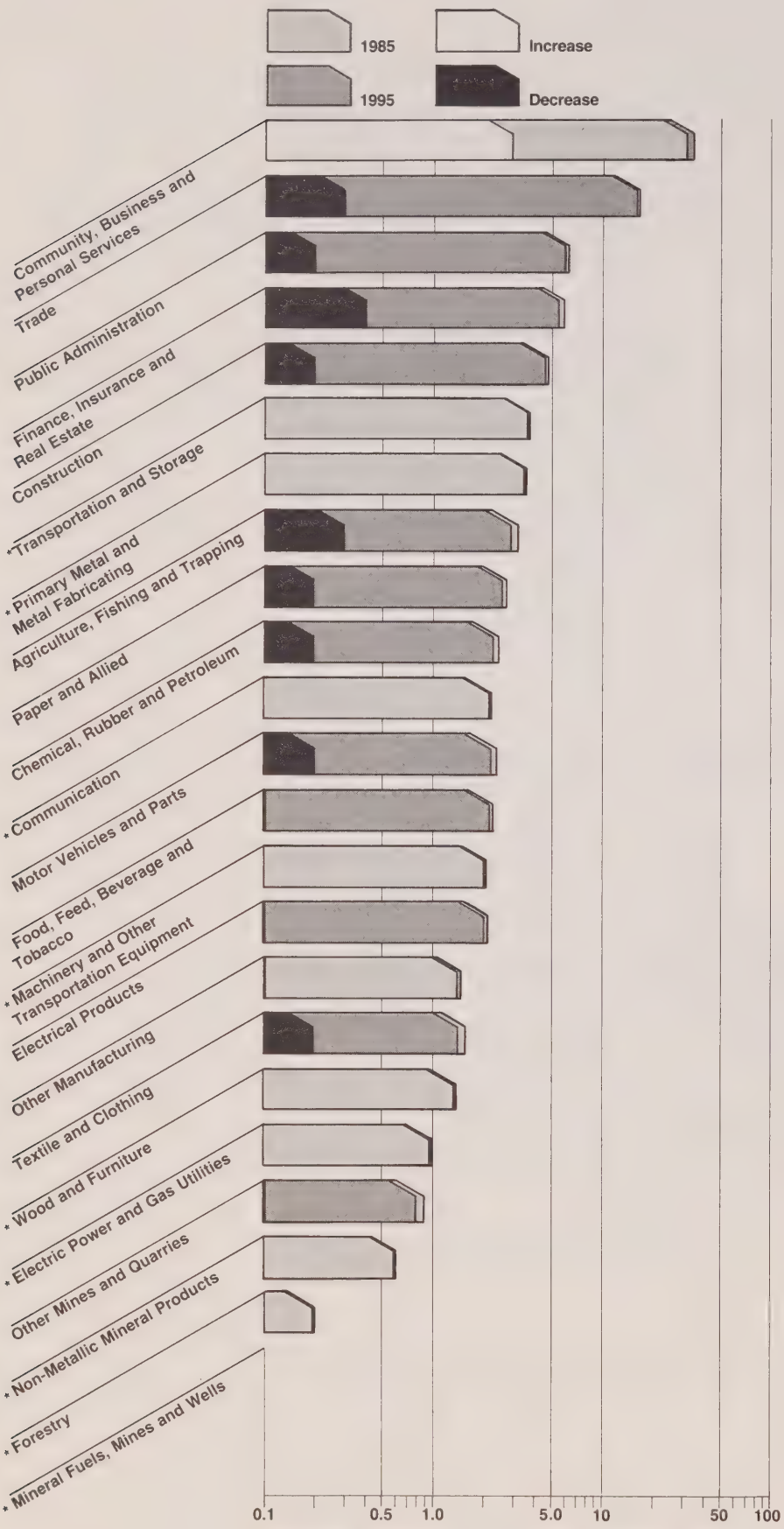
Employment and Employment Growth in the Community, Business and Personal Services Sector in Ontario, 1985 to 1995



NOTE Bars are one behind another with the smallest at the front.
Source: Appendix 19

Figure 5.3

Distribution of Employment by Industry-Sector in Ontario, 1985 and 1995



*No change 1985 to 1995

NOTE Bars are one behind another with the smallest at the front.
Source: Appendix 19

5.3 Occupational Employment Levels, 1985-1995

There were profound changes in patterns of employment for major occupational groups in Ontario over the last fifty years. As new technology takes hold in Ontario over the next decade, the skill requirements in our workplaces will continue to change. We have therefore paid particular attention to means for estimating changes in occupational compositions, sector by sector, since they will reflect the changing patterns of skills required by industry as new technology is adopted.

In the estimation of occupational compositions, most occupational projection systems use the most comprehensive source of information, Census data, which are available in Canada only every ten years. Because of this limitation, most occupational projection models tend to assume fixed occupational distributions for future time periods. This is clearly inappropriate when attempting to estimate changes in future occupational employment patterns affected by technological change.

In our research design, we have recognized the importance of using an approach which allows industry-sector occupational compositions to flexibly change over future time under carefully monitored circumstances. Our approach has incorporated the findings of the future-oriented research projects we initiated to examine the likely employment implications of new technology on selected industries and occupations, and statistical analyses using Labour Force Survey and Census data to identify occupational employment trends.

We have brought together data regarding industry-sector employment with estimates of industry-sector occupational compositions to provide estimates of occupational employment levels in each industry-sector. The results are presented in Tables 5.3, 5.4, 5.5, and Figures 5.4 and 5.5, and are for aggregated data across all industry-sectors. Details for each industry-sector are presented in Appendix 19. Patterns which we identify in the overall data are as follows:

5.3.1 Almost All Occupational Groups are Expected to Gain in Employment

In aggregate, all of the 23 major occupational groups are expected to gain in employment over the 1985-1995 period (with the exception of Teaching occupations and Fishing, Hunting and Trapping occupations).

5.3.2 Five Occupational Groups are Expected to Account for Most Employment Growth

Of the 750,000 new jobs expected to be created over this period, five occupational groups together are projected to account for approximately 75 percent of employment growth. These occupational groups are:

- Clerical occupations (21 percent of growth)
- Service occupations (19 percent of growth)
- Managerial and Administrative occupations (13 percent of growth)
- Natural Sciences, Engineering and Mathematics occupations (9 percent of growth)
- Sales occupations (8 percent of growth)

5.3.3 Employment Growth is Expected to be Concentrated in Certain Industries and Occupations

The occupational groups identified in the seven industry-sectors noted in Table 5.5 are expected to account for about 460,000 new jobs over the 1985-1995 period, or over 60 percent of all new jobs to be created in Ontario during this period.

The identified occupational groups are expected to account for almost all the new jobs to be created in the Trade, Finance, Insurance and Real Estate, and Public Administration sectors.

Employment growth of some occupations is also expected to be dominated by particular industry-sectors; for example, the Community, Business and Personal Services sector is expected to account for almost 92 percent of the new jobs to be created for Service occupations in Ontario.

Table 5.3 **Employment Distribution by Occupation in Ontario, 1985 and 1995**

Occ. Code	Occupation	Expected Employment (000) 1985	Expected Employment (000) 1995	Employment Growth (000) 1985–1995
41	Clerical	838	995	157
61	Service	537	676	139
11	Managerial and Administrative	355	452	97
21	Natural Sciences	180	249	69
51	Sales	383	439	56
85	Fabricating	369	410	40
31	Medicine	181	207	26
23	Social Sciences	75	99	24
87	Construction	202	226	24
33	Artist	60	79	19
81	Processing	149	166	17
91	Transportation	136	152	17
83	Machining	125	141	15
71	Farming	144	151	7
93	Material Handling	91	97	7
95	Other Crafts	56	62	6
37	Sports	13	18	5
77	Mining	18	19	2
25	Religion	11	12	1
75	Forestry	9	11	1
73	Fishing	2	1	0
27	Teaching	181	179	(2)
99	Other Occupations	97	115	18
	Total	4,211	4,954	743

Source: Appendix 19

Table 5.4 **Employment and Employment Growth by Occupation in Ontario, 1985 to 1995**

Occ. Code	Occupation Name	Expected Employment						Employment Growth					
		1985		1990		1995		1985 to 1995		1985 to 1990		1990 to 1995	
		Total (000)	% of Total	Total (000)	% of Total	Total (000)	% of Total	Total (000)	% of Total	Total (000)	% of Total	Total (000)	% of Total
11	Managerial and Administrative	355	8.4	412	9.1	452	9.1	97	13.0	57	17.1	40	9.7
21	Natural Sciences	180	4.3	221	4.8	249	5.0	69	9.2	41	12.1	28	6.9
23	Social Sciences	75	1.8	86	1.9	99	2.0	24	3.2	11	3.4	13	3.1
25	Religion	11	0.3	11	0.2	12	0.2	1	0.2	0	−0.1	2	0.4
27	Teaching	181	4.3	178	3.9	179	3.6	−2	−0.4	−3	−0.7	0	0.0
31	Medicine	181	4.3	182	4.0	207	4.2	26	3.4	0	0.1	25	6.2
33	Artist	60	1.4	69	1.5	79	1.6	19	2.6	10	2.9	9	2.3
37	Sports	13	0.3	14	0.3	18	0.4	5	0.7	2	0.5	4	0.9
41	Clerical	838	19.9	907	19.9	995	20.1	157	21.2	69	20.6	88	21.7
51	Sales	383	9.1	409	9.0	439	8.9	56	7.5	26	7.7	30	7.4
61	Service	537	12.7	601	13.2	676	13.6	139	18.7	64	19.1	75	18.4
71	Farming	144	3.4	147	3.2	151	3.1	7	0.9	2	0.7	4	1.1
73	Fishing	2	0.0	1	0.0	1	0.0	0	0.0	0	0.0	0	0.0
75	Forestry	9	0.2	10	0.2	11	0.2	1	0.2	1	0.1	1	0.2
77	Mining	18	0.4	19	0.4	19	0.4	2	0.2	1	0.3	1	0.1
81	Processing	149	3.5	157	3.5	166	3.4	17	2.3	8	2.4	9	2.2
83	Machining	125	3.0	132	2.9	141	2.8	15	2.1	7	2.1	8	2.0
85	Fabricating	369	8.8	386	8.5	410	8.3	40	5.4	17	5.0	23	5.7
87	Construction	202	4.8	209	4.6	226	4.6	24	3.2	7	2.0	17	4.1
91	Transportation	136	3.2	141	3.1	152	3.1	17	2.2	5	1.6	11	2.8
93	Material Handling	91	2.2	91	2.0	97	2.0	7	0.0	1	0.2	6	1.4
95	Other Crafts	56	1.3	57	1.3	62	1.2	6	0.8	1	0.3	5	1.1
99	Other Occupations	97	2.3	106	2.3	115	2.3	18	2.4	10	2.8	9	2.1
	Total	4211	100.0	4547	100.0	4954	100.0	743	100.0	336	100.0	407	100.0

Source: Appendix 19

5.3.4 Projected Occupational Employment Levels are Sensitive to Estimates of Occupational Composition

There are significant differences of projected occupational employment growth over the 1985-1995 period when using the flexible and fixed occupational distribution approaches. If, for example, one were to assume the 1995 industry-sector occupational distributions to be the same as those of 1981, while assuming the flexible occupational compositions were in fact somewhat closer to the correct values, then one would overestimate the increase in demand for Teaching occupations over ten years by about 56,000 persons and Medicine and Health occupations by about 28,000, and underestimate the requirements for Managerial and Administrative occupations by about 44,000 and Natural Sciences, Engineering and Mathematics occupations by about 40,000. (More details may be found in Appendix 19.)

5.3.5 Projected Occupational Employment Levels are Sensitive to Industry Employment Estimates

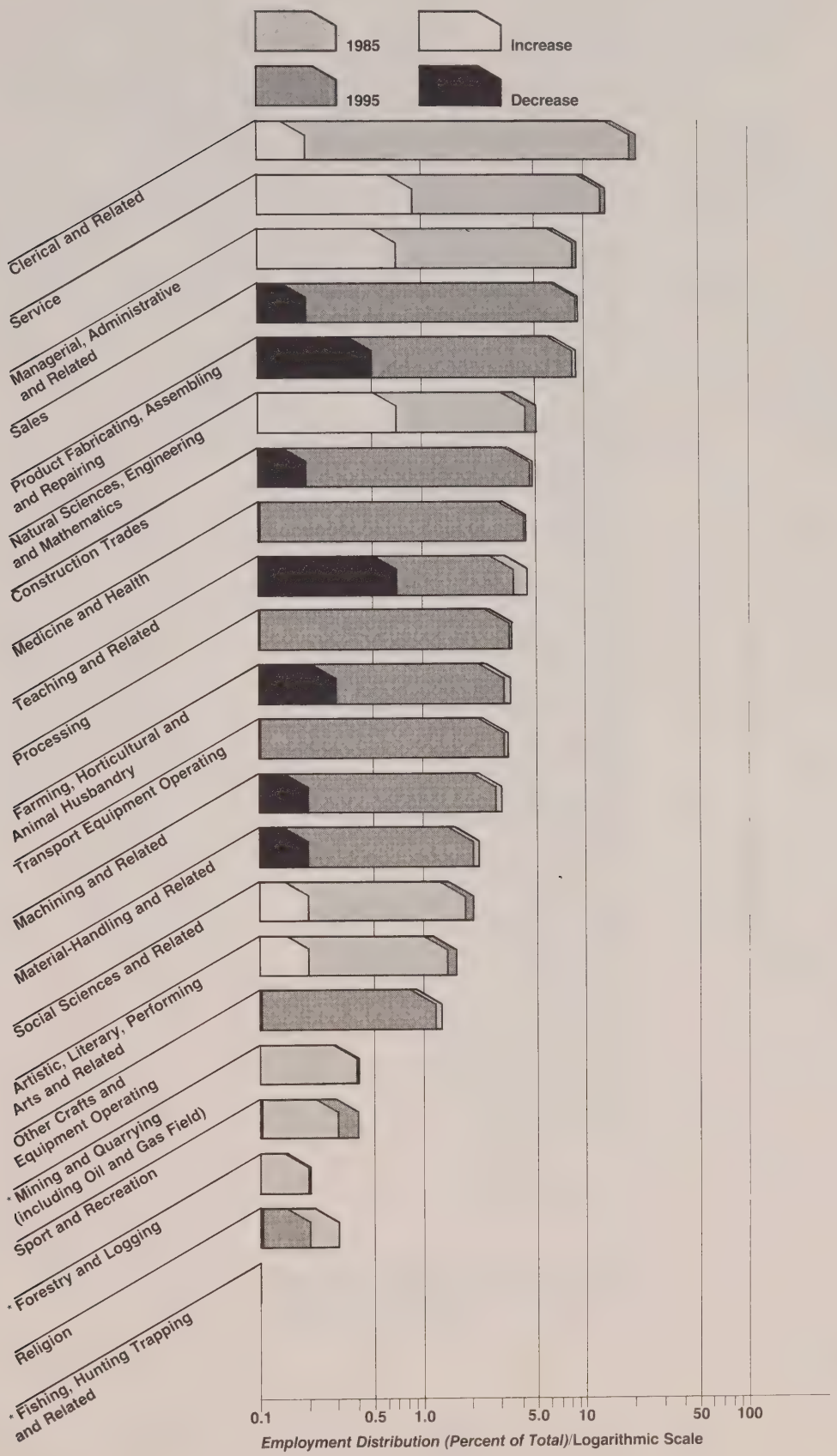
Occupational employment levels for each industry-sector are directly related to the industry employment estimates for future time periods. Thus changes in the estimates for industry employment will affect the occupational employment estimates. The studies of the overall economy in Chapter 6 develop ranges of employment levels connected with future productivity improvements; these are +0, −1 percent; +1, −4 percent; +2, −5 percent of overall employment for the years 1985, 1990, and 1995 respectively. In Appendix 19 we have used these ranges on our industry-sector employment estimates to determine what the related outcomes might be for occupational employment.

Table 5.5 **Large Contributors to Expected Employment Growth in Ontario, 1985 to 1995**

Ind. Code	Industry	All Occ. Total (000)	Clerical	Service	Managerial and Administrative	Sales	Natural Sciences	Selected Occupations Total (000)	Selected Occupations As % of All Occ.
All Industries Total (000)		743	157	139	97	56	69	518	70%
22	Community, Business and Personal Services	385	80	129	37	9	40	296	77%
20	Trade	110	32	0	19	41	2	94	86%
23	Public Administration	25	5	8	6	0	3	22	88%
18	Transportation	26	7	1	3	0	0	11	42%
9	Primary Metal and Fabricating	24	3	0	2	0	3	7	30%
21	Finance and Insurance	22	7	1	5	5	5	23	103%
16	Construction	29	4	0	5	0	0	9	32%
Selected Industries Total (000)		621	137	139	77	56	53	462	74%
Other Industries Total (000)		122	20	0	20	0	16	56	
Selected Industries as % of All Industries		84%	87%	100%	80%	100%	58%	89%	

Source: Appendix 19

Figure 5.4 **Distribution of Employment by Occupation in Ontario, 1985 and 1995**

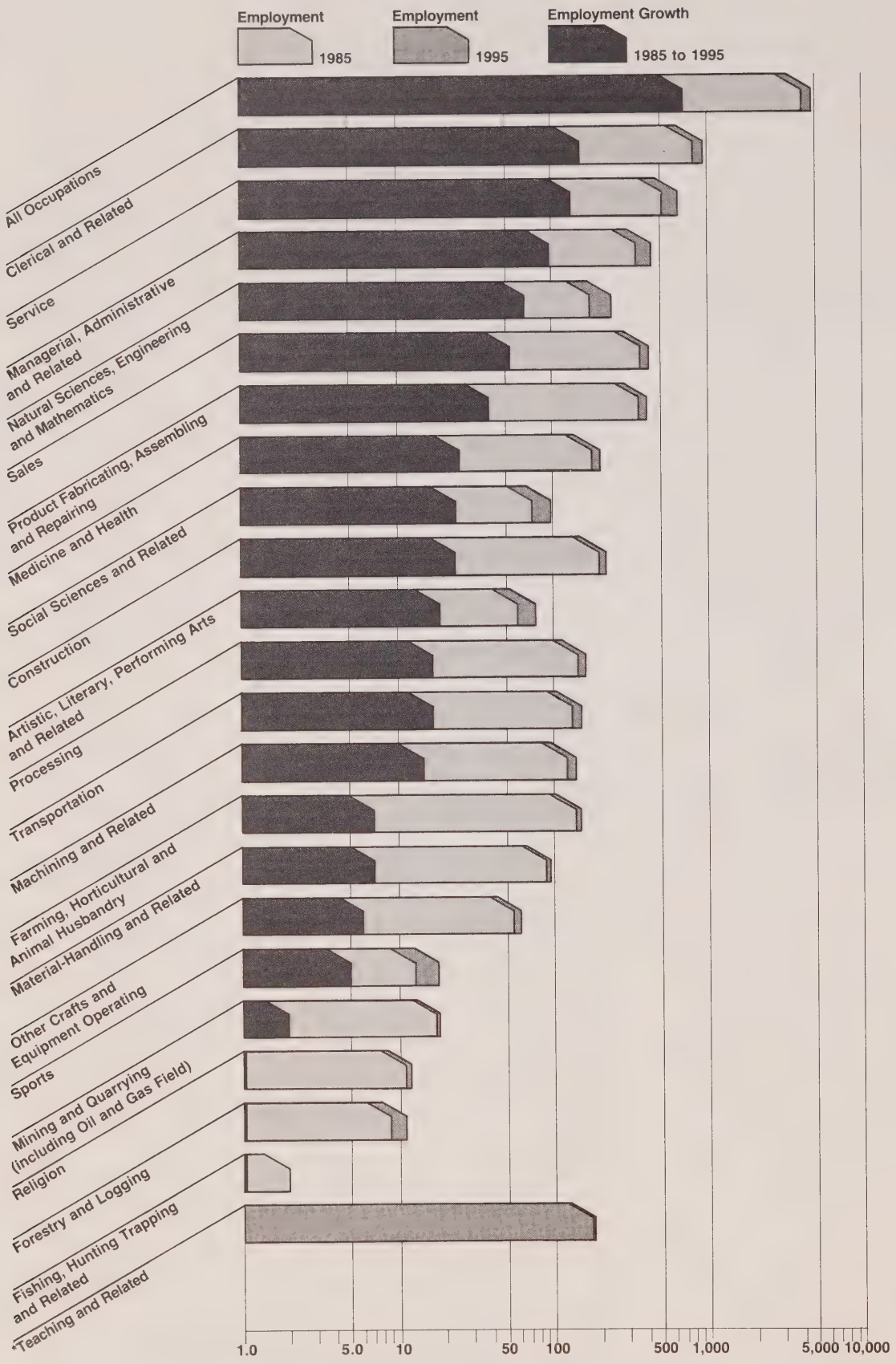


*No change 1985 to 1995

NOTE Bars are one behind another with the smallest at the front.
Source: Appendix 19

Figure 5.5

Employment and Employment Growth, by Occupation in Ontario, 1985 to 1995



NOTE Bars are one behind another with the smallest at the front.
Source: Appendix 19

*1985 to 1995: −2.0

5.4 Comparison of 1971-1981 and 1985-1995 Employment Patterns

The aggregation of median employment estimates for the 23 industry-sectors indicates that total employment in Ontario will increase by approximately 750,000 persons over the next decade; this compares with employment growth of approximately one million over the 1971-1981 period. However, the labour force in Ontario is also expected to grow at a much slower pace with forecasts ranging between 644,000 and 712,000 over the 1985-1995 period compared to actual growth of 1,140,000 over 1971-1981, and the overall employment growth picture for Ontario should be viewed in that context (see Appendix 19).

In order to establish a perspective on the employment estimates for the 1985-1995 period, we have made comparisons with similar data for the 1971-1981 period. Comparisons are made of industry-sector employment growth in Table 5.6, changes in occupational distributions in Table 5.7, and occupational employment growth in Table 5.8. These data are illustrated in Figures 5.6 and 5.7.

The comparisons reveal there are significantly different patterns of industry-sector and occupational employment growth expected to occur over the next decade.

5.4.1 Industry-Sector Employment Growth

Relative to the 1971-1981 period, industry-sectors which are expected to contribute a larger share of overall employment growth in Ontario over the next decade include:

- Community, Business, and Personal Services
- Construction
- Electrical Products
- Food, Feed, Beverage and Tobacco
- Other Manufacturing

Conversely, industry-sectors which are expected to contribute a smaller share of employment growth include:

- Trade
- Transportation and Storage
- Public Administration
- Primary Metal and Metal Fabricating
- Finance, Insurance, and Real Estate
- Communication
- Machinery and Other Transportation
- Wood and Furniture
- Chemical, Rubber and Petroleum
- Utilities
- Motor Vehicles and Parts

Industry-sectors which are expected to have no employment growth at all during the 1985-1995 period include:

- Textile and Clothing
- Mineral Fuel Mines and Wells

Many industry-sectors are expected to contribute significantly less to employment growth over the next decade than during the 1970's. Major changes are expected in: Trade; Public Administration; and Finance, Insurance and Real Estate. Manufacturing industry-sectors are only expected to contribute about one-half the number of additional new jobs for the next decade which were created during the 1970's.

5.4.2 Changes in Occupational Distribution

Occupational groups which are expected to continue to increase their share of the overall occupational distribution over the 1985-1995 period include:

- Service occupations
- Natural Sciences, Engineering, and Mathematics occupations
- Managerial and Administrative occupations
- Clerical occupations
- Social Sciences and Related occupations
- Artistic, Literary, Performing Arts and Related occupations

Table 5.6 **Employment Growth by Industry-Sector in Ontario, 1971 to 1981 and 1985 to 1995**

Ind. Code	Industry	Actual Employment Growth (000) 1971–1981	Expected Employment Growth (000) 1985–1995	Actual % of Total 1971–1981	Expected % of Total 1985–1995
22	Community, Business and Personal Services	418	385	41.4	51.8
20	Trade	215	110	21.3	14.8
16	Construction	33	29	3.3	3.9
18	Transportation and Storage	40	26	4.0	3.5
23	Public Administration	50	25	5.0	3.4
9	Primary Metal and Metal Fabricating	37	24	3.7	3.2
21	Finance, Insurance and Real Estate	97	22	9.6	3.0
19	Communication	29	18	2.9	2.4
11	Machinery and Other Transportation	26	15	2.6	2.0
8	Paper and Allied	19	12	1.9	1.6
12	Electrical Products	14	12	1.4	1.6
15	Other Manufacturing	14	12	1.4	1.6
5	Food, Feed and Tobacco	12	11	1.2	1.5
7	Wood and Furniture	22	9	2.2	1.2
13	Chemical, Rubber and Petroleum	26	8	2.6	1.1
17	Utilities	17	8	1.7	1.1
10	Motor Vehicles and Parts	13	6	1.3	0.8
4	Other Mines	1	4	0.1	0.5
1	Agriculture, Fishing and Trapping	8	3	0.8	0.4
2	Forestry	5	2	0.5	0.3
14	Non-Metallic Mineral Products	2	2	0.2	0.3
3	Mineral Fuel and Mines	1	0	0.1	0
6	Textile and Clothing	16	0	1.6	0
99	Other Industries	(103)		(10.2)	
	All Industries	1,009	743	100.0	100.0

Source: Appendix 19

Occupational groups which are expected to reverse their growth pattern from the 1971-1981 period and begin to lose their share of the overall occupational distribution over the 1985-1995 period include:

- Teaching occupations
- Product Fabricating, Assembling and Repairing occupations
- Medicine and Health occupations
- Sales occupations

Occupational groups which are expected to continue to decrease their share of the overall occupational distribution over the 1985-1995 period include:

- Farming, Horticultural and Animal-Husbandry occupations
- Machining occupations
- Construction Trades occupations
- Processing occupations
- Transport Equipment Operating occupations
- Material Handling and Related occupations

Table 5.7 **Occupational Distribution in Ontario, 1971 to 1995**

		Occupational Distribution				
		Actual		Expected		
Occ. Code	Occupation	1971 % of Total	1981 % of Total	1985 % of Total	1990 % of Total	1995 % of Total
11	Management and Administrative	4.9	7.5	8.4	9.1	9.1
21	Natural Sciences	3.2	3.9	4.3	4.8	5.0
23	Social Sciences	1.0	1.7	1.8	1.9	2.0
25	Religion	0.2	0.2	0.3	0.2	0.2
27	Teaching	4.0	4.0	4.3	3.9	3.6
31	Medicine	3.8	4.2	4.3	4.0	4.2
33	Artist	0.8	1.2	1.4	1.5	1.6
37	Sports	0.2	0.2	0.3	0.3	0.4
41	Clerical	17.6	19.5	19.9	19.9	20.1
51	Sales	9.7	9.7	9.1	9.0	8.9
61	Service	10.5	11.2	12.7	13.2	13.6
71	Farming	4.4	3.5	3.4	3.2	3.1
73	Fishing	0.0	0.0	0.0	0.0	0.0
75	Forestry	0.3	0.2	0.2	0.2	0.2
77	Mining	0.6	0.4	0.4	0.4	0.4
81	Processing	3.6	3.6	3.5	3.5	3.4
83	Machining	3.8	3.3	3.0	2.9	2.8
85	Fabricating	8.2	8.7	8.8	8.5	8.3
87	Construction	6.1	5.3	4.8	4.6	4.6
91	Transportation	3.6	3.4	3.2	3.1	3.1
93	Material Handling	2.4	2.2	2.2	2.0	2.0
95	Other Crafts	1.4	1.3	1.3	1.3	1.2
99	Other Occupations	9.7	4.6	2.3	2.3	2.3
	Total	100.0	100.0	100.0	100.0	100.0

Source: Appendix 19

5.4.3 Occupational Employment Growth

While the levels of employment in all major occupational groups are expected to grow during the next decade (with the exception of Teaching occupations), five major occupational groups are expected to account for about 70 percent of overall employment growth: Clerical; Service; Natural Sciences, Engineering and Mathematics; Managerial and Administration; and Sales occupations.

Only two major occupational groups are expected to account for a significantly larger share of overall employment growth during the next decade than they did over the 1970's: Natural Sciences, Engineering and Mathematics; and Service occupations.

Many other major occupational groups will have a reduced share of overall employment growth. Clerical and Fabricating occupations, for example, will only grow at half their recent rates.

Although Teaching occupations experienced an employment growth of 41,000 over the 1971-1981 period, reduced employment levels may be experienced over the 1985-1995 period. (While survey responses and other data inputs cause this result, the survey results which show an increased industrial emphasis on future education and training appear contradictory and suggest the projection is particularly sensitive to future policy decisions.)

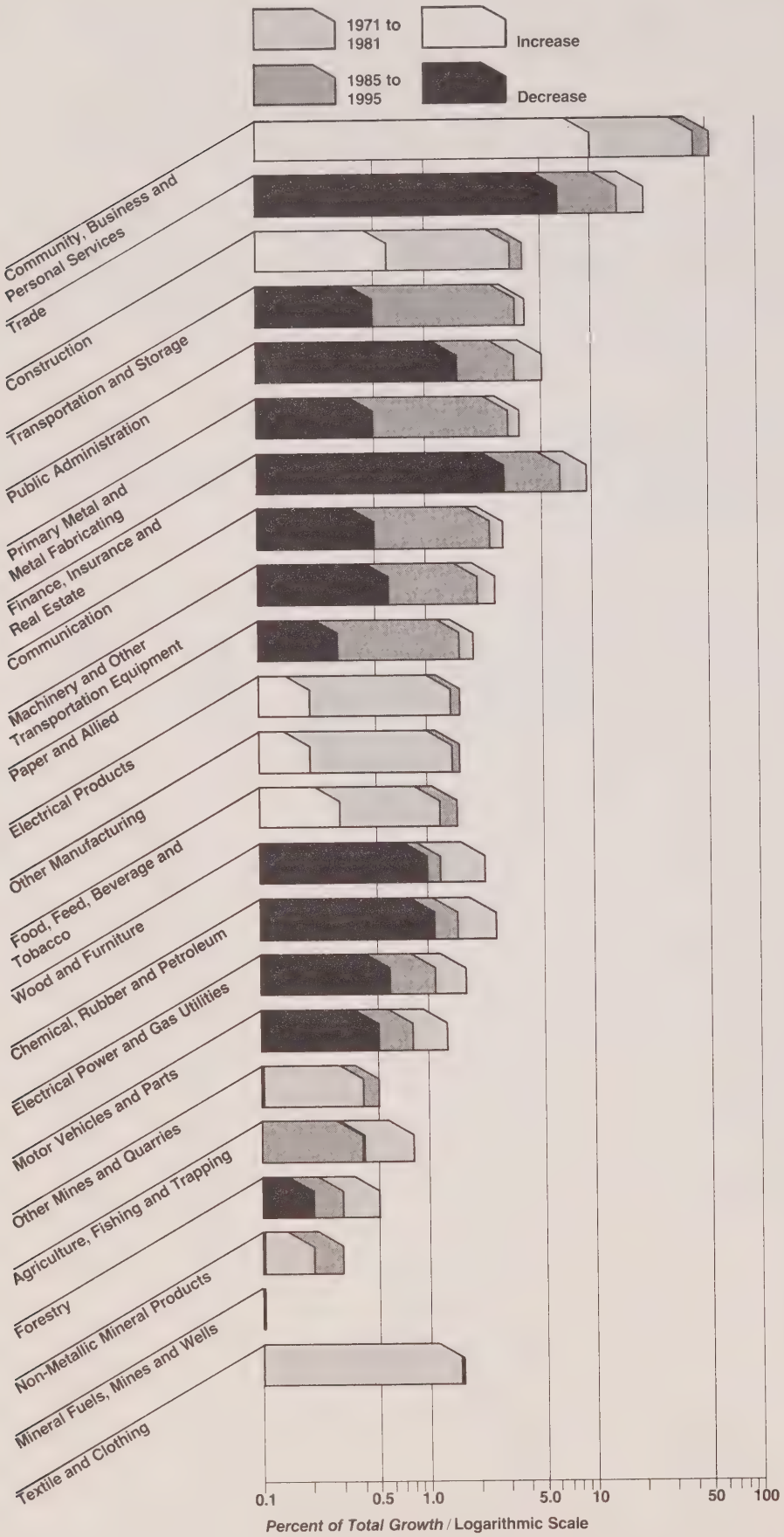
Table 5.8 **Employment Growth by Occupation in Ontario, 1971 to 1981 and 1985 to 1995**

Occ. Code	Occupation	Actual Employment Growth (000) 1971–1981	Expected Employment Growth (000) 1985–1995	Actual % of Total 1971–1981	Expected % of Total 1985–1995
41	Clerical	256	157	25.4	21.2
61	Service	134	139	13.3	18.7
11	Managerial and Administrative	160	97	15.9	13.0
21	Natural Sciences	60	69	5.9	9.2
51	Sales	98	56	9.7	7.5
85	Fabricating	104	40	10.3	5.4
31	Medicine	54	26	5.4	3.4
23	Social Sciences	38	24	3.8	3.2
87	Construction	29	24	2.9	3.2
33	Artist	25	19	2.5	2.6
81	Processing	37	17	3.7	2.3
91	Transportation	29	17	2.9	2.2
83	Machining	19	16	1.9	2.1
71	Farming	7	7	0.7	0.9
93	Material Handling	16	7	1.6	0.9
95	Other Crafts	12	6	1.2	0.8
37	Sports	5	5	0.5	0.7
77	Mining	(1)	2	(0.1)	0.2
75	Forestry	1	1	0.1	0.2
25	Religion	2	1	0.2	0.2
73	Fishing	0	0	0.0	0.0
27	Teaching	41	(2)	4.1	(0.3)
99	Other Occupations	(115)	18	(11.4)	2.4
	All Occupations	1,009	743	100.0	100.0

Source: Appendix 19

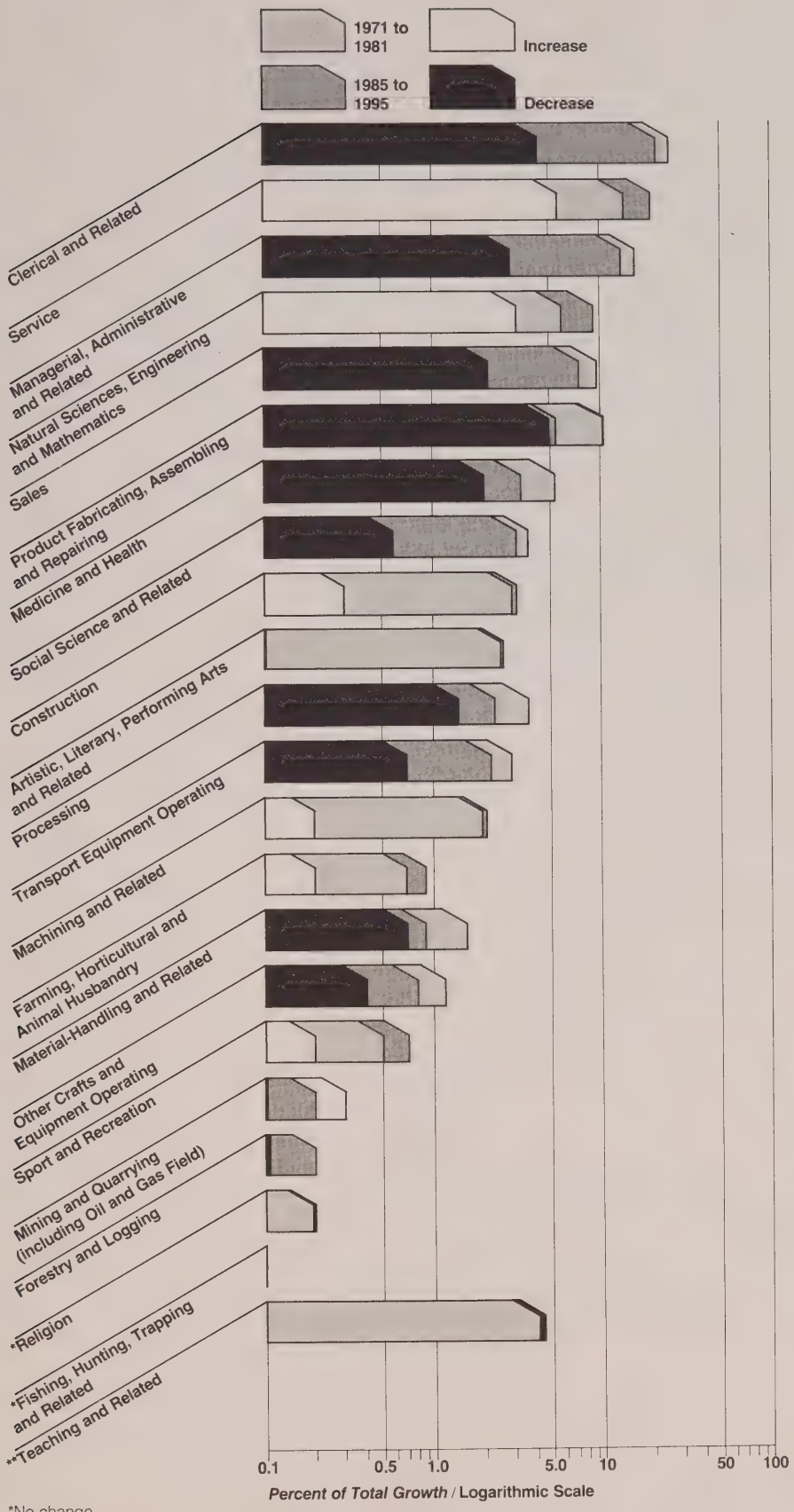
Figure 5.6

Industry-Sector Shares (%) of Total Employment Growth in Ontario, 1971 to 1981 and 1985 to 1995



NOTE Bars are one behind another with the smallest at the front.
Source: Appendix 19

Figure 5.7 **Occupational Shares (%) of Total Employment Growth in Ontario, 1971 to 1981 and 1985 to 1995**



*No change between periods
**1985 to 1995: −0.3

NOTE Bars are one behind another with the smallest at the front.
Source: Appendix 19

CHAPTER 6 6 6 6

Employment and New Technology, 1985 to 1995: Studies of the Overall Economy

Chapter Contents

6.1 Introduction

As we have earlier observed, in order to establish a well-informed picture of the extent and nature of the employment impacts of technological change, it is necessary to use a research methodology which spans the levels of the firm and industry, the industry-sector, and that of the overall economy.

In this chapter we turn our attention to studies of the overall economy. We do so because economic analysis suggests that there are factors at work in the economy as a whole whose effects are not immediately apparent in the examination of individual units. As we all know, it is unfortunately quite possible for a firm or industry to close down, or even for a whole single-industry community to be thrown out of work. But it is much less likely for this to happen to a whole economy, simply because if a whole economy is affected by low demand and high unemployment, then wages, prices, the exchange rate and monetary and fiscal mechanisms will all begin to respond. These factors, although slowly, will tend to push the economy toward more employment again. True, people may end up employed at different jobs, and the costs of transition may be high, but there are 'equilibrating' forces at work which are not apparent in the examination of single firms or industries. To get a picture of the impact of technology on employment as a whole we therefore need an overall analysis which can register the influence of the economy-wide equilibrating mechanisms which are not directly apparent in other types of studies.

The purpose of this chapter is to report the results of studies we have commissioned to examine the technology-employment question in the overall economy as a supplement to studies of particular industries and industry-sectors (for details see Appendix 20).

6.2 The Nature of the Studies

We have commissioned two independent investigations using computer simulation models of the economy.[19] The analyses ask 'what if?' questions about the future, using productivity improvements as a proxy for technological change, in order to determine a range of possible employment impacts which could be associated with future adoption of new technology.

Our emphasis in these analyses has not been to make overall economic forecasts, nor to forecast whether increased productivity improvements will occur. Rather, our interest is to determine what the range of possible employment outcomes could

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19 The studies were performed by: Dr. P. Dungan, University of Toronto, and Dr. A. Younger, Consultant; Dr. L. de Bever, Chase Econometrics Canada.
The relationships between economic variables utilized by these models are not universally accepted. Appendix 20 contains comments challenging the design of these models from Sam Gindin, Research Director, United Auto Workers Union of Canada. His critique questions the relationship between income distribution, relative prices of labour and employment levels, and argues that the theoretical and empirical case has not been established that wage restraint will provide additional jobs.

be if additional productivity improvements were to occur. Therefore, we have requested two independent economic forecasting organizations to examine, relative to their projections for the 1985-1995 period (which we refer to here as their base-cases), what the employment consequences might be of different and additional future productivity improvements. Thus, we show relatively little interest in what the base-case projections might be of these researchers, and we deliberately avoid making judgements as to which base-case projection is more likely to be correct than the other. Rather, we are interested in what the models can tell us about the range of employment outcomes which might possibly result from additional future productivity improvements relative to their base-case projections. In this way we avoid unnecessary comparisons of the base-case projections, and concentrate our attention more on what the complex relationships linking technological change and employment in these models may offer as guidance for the future.

The method by which the analyses were done is straightforward. First, the computer models were used by the researchers to generate base-case projections for the economy over the 1985-1995 period. The employment projections independently resulting from these base-cases are shown in Table 6.1. Second, various additional possible productivity improvements for the future period were entered into the models generating in each case an alternative set of outcomes. The differences between these alternative employment outcomes and the original base-cases are then measures of the direct and indirect impacts resulting from the assumed additional productivity improvements. Importantly, these differences establish patterns of employment changes, both of direction and relative magnitude, which can be associated with technological change. Our purpose, therefore, is to examine the possible range of employment outcomes associated with future productivity improvements and technological change.

In one of these simulations, a study was first undertaken to determine whether the employment outcomes resulting from future productivity improvements depend on the nature of the productivity improvement. The purpose of this study was to ascertain whether the nature of the technological change, as represented by different types of productivity improvements, have an important bearing on the extent and nature of the overall employment impacts. Then we requested our researchers to examine the impacts of additional assumed productivity improvements for the 1985-1995 period. Each of our two independent studies was requested to use the same magnitude of assumed additional productivity improvements over and above their base-cases. As these productivity improvements were entered into the models, alternative scenarios were run to determine the range of possible employment outcomes which depend upon how the productivity 'dividends' are distributed in the economy. Similarly, the effect of different assumptions about the economic environment, and how they might affect possible employment outcomes resulting from additional productivity improvements, were also tested.

In these analyses, we do not presume to say how the dividends resulting from productivity improvements should be distributed in the economy. Our interest simply lies in conducting an examination of what the possible range of employment consequences might be of different and equally valid scenarios.

Table 6.1 **Base-Case Employment Projections**
(Percent Increase Relative to 1985 Levels)

	1985	1986	1987	1990	1994
Study A	0	+2	+4	+11	+19
Study B	0	+2	+4	+13	+20

Source: Appendix 20

6.3 Possible Employment Outcomes Resulting from Different Types of Productivity Improvement

In this section we report the results of the study to determine the employment outcomes associated with different types of productivity improvement. The purpose of this study was to ascertain whether different types of productivity improvement have an important bearing on the extent and nature of the associated employment impacts.

Assuming for the moment that goods and services are produced using only two types of economic inputs, labour and capital, and that the shares of total income accruing to labour and capital remain unaltered, one can identify three possible types of productivity improvement. First, in economists' terms, technological change is said to be "labour-saving," if, as output rises, the ratio of capital-to-output remains constant while that of labour-to-output falls (bear in mind that no absolute decline in employment is implied if output rises; moreover, it would be possible for real wages to rise). Second, were the reverse to be the case the change is said to be "capital-saving." Third, were these two to occur simultaneously, a constant capital-to-labour ratio would be noted over time, even as the rate of production rises; if both factors are becoming more efficient at the same rate, this is referred to as a "total factor productivity improvement," or a saving of both capital and labour together.

In one of our researchers' simulations, the employment consequences of these different types of productivity improvement were examined by means of the following methodology:

- First, to examine the effects of labour-saving productivity the model assumed a private-sector labour force more effective in the future than the base-case by 0.5 percent per year, cumulatively. Such an increment is well within the historical range for variations in labour productivity.
- Second, to examine the impact of purely capital-saving productivity improvement, a simulation was run in which new capital, put in place in 1985 and after, was assumed to be more effective than in the base-case. Specifically, the new plant was assumed to be 5 percent more effective, and new machinery and equipment 20 percent more effective (note these adjustments are averages; for machinery and equipment this could translate as one-fifth of new equipment being twice as effective as the old it replaces).
- Third, to examine the impact of both labour and capital improvements, total factor productivity was assumed to increase by 0.5 percent annually and cumulatively above the base-case. (For perspective, an increase of 0.5 percent would restore somewhat less than half of the productivity growth slowdown between the late 1960's and the early 1980's; that is, productivity growth proceeded at about 1.5 to 2.0 percent per year in the 1960's, and in the late 1970's it fell to 0.5 percent per year and below.)

These simulations yield interesting results. The most important of these is that the type of productivity enhancement, whether concentrated on saving labour, or capital, or both, apparently matters very little to the outcome for overall employment. As will be later seen, our researchers tell us there are more critical factors. However, at first sight, this result is somewhat surprising, and merits comment. The result is derived from the computer model's view of the aggregate economy in which, based on historical relationships, labour and capital will be substituted for each other depending upon their relative prices. In aggregate, such substitutability is seen to be possible. Thus, when productivity is enhanced, no matter what the enhancement's source, the mix of capital and labour used to produce total supply depends primarily on their relative prices. Moreover, with a lag of some years, real wages will reflect increases in output-per-employee no matter what the source of the improvement. There will be a secondary adjustment of employment in response, but again the source of the productivity enhancement matters little since the relative price of labour depends on changes in output-per-employee no matter what their source. Of course, if capital and labour are used more in fixed proportions then relative enhancements of one or the other will have different effects on employment. Certainly, fixed proportions may well be the case in particular sectors of the

economy, but, for the economy as a whole, the results of the study suggest that the source of productivity enhancement is of little concern to overall employment relative to other factors.

6.4 Possible Employment Outcomes and the Productivity Dividends Derived from Technological Change

A question which lies at the heart of concerns over technology and aggregate levels of employment relates to the distribution of total income. In large measure, concerns regarding technological change are about the extent to which profits, wages, and the number of remunerative jobs which are available will be affected.

The simulations reported in the previous section, which were run to examine the effects of the type of productivity improvement, all revealed that no matter what the source of productivity improvement, extra productivity resulting from technological change creates extra income. This extra income is referred to as the "productivity-dividend." The employment impacts of productivity improvements resulting from technological change depend on how the dividends are distributed in the economy.

In examining this question, we do not attempt to say what the responses of different sectors of the economy should be to opportunities afforded by productivity improvements. Rather, our interest is simply to examine the range of possible employment outcomes which could result from different arrangements for distributing the productivity dividends. As important factors affecting possible employment outcomes: first, we examine the influence of different corporate strategies regarding prices and profits; second, we examine the influence of different wage-settings on possible employment outcomes.

6.4.1 Possible Employment Outcomes Resulting from Alternative Responses of Corporate Pricing and Profits to Productivity Improvements

There is an ongoing debate about how prices are set in the economy. Clearly, there are some markets in which prices respond very quickly to pressures of supply and demand; for example, those for internationally traded primary commodities.

But there are also markets, generally for manufactured goods with few producers, where prices are more determined by the deliberate decisions of firms; these prices also respond to forces of supply and demand, but the response may be more sluggish and take longer to occur.

The initial impact of an enhancement of productivity is to reduce firms' costs of producing goods. At the extremes, two reactions are possible.

First, prices could fall (or simply not rise as much); this could curtail some firms' desire to supply goods, but, more importantly, it would stimulate demand for output. The most important demand stimulation would be with respect to foreign markets. Canadians would find it easier to export and to replace imports at home. That is, enhanced productivity would make Canadian goods more competitive. Under the second possibility, that of sluggish prices, prices would adjust little, demand would stay put, and supply would be provided through more productive plant and equipment, and therefore by cutting back on the use of older plant and some of the workforce. In this case, enhanced productivity is used to increase profit margins, but not necessarily total profits.

A comparison of the employment outcomes connected with these extremes is shown in Table 6.2. According to our researchers' studies, there are pronounced effects on employment when a portion of the productivity dividends is not used to stabilize or lower prices. Without a pass-through there would be virtually no gain in economic output, and, in the first few years, the labour market dislocations would cause an economic output loss. Since there is no gain in output, but still some rise in output per worker, there would be employment losses. One of our researchers feels that a sluggish price scenario is unlikely to occur, especially in the long run, since market forces would be too powerful to resist. However, something like this could possibly occur in the short-term as a result of actions by those firms with large influence in their markets choosing to pursue pricing strategies with short-term profit-building primarily in mind.

6.4.2 Possible Employment Outcomes Resulting from Alternative Wage Responses to Productivity Improvements

Just as there is some question as to how firms might respond to enhanced productivity in the setting of their prices, so there are different possibilities for wage-setting approaches by labour when productivity is boosted. The employment outcomes of two such possibilities have been examined by our researchers.

In the first case, the assumption was made that labour would negotiate aggressively so as to incorporate the result of all increases in output per worker into a rise in real wages. The likely employment results of this strategy are shown in Table 6.2. In the second case, labour is assumed to negotiate so as to seek a rise in real wages, but at a slower rate of increase.

The studies done by both researchers suggest that the results of moderating real wage increase targets include higher economic output, lower inflation, and an improvement in employment levels. In effect, this alternative uses a portion of the productivity-dividends to create higher employment rather than real incomes for those already employed.

Table 6.2 **Employment Outcomes Which Could Result from Alternative Price and Wage Responses to Additional Productivity Improvements**

	Employment Outcomes from Different Price Responses. (Percent of Base-Case Projection for Year)				
	1985	**1986**	**1987**	**1990**	**1994**
'Sluggish' Prices					
Study A	−1.0	−2.2	−3.1	−4.9	−5.8
Study B	−0.2	−0.5	−0.7	−1.5	−2.2
'Flexible' Prices					
Study A	−0.1	−0.2	−0.3	−0.3	−0.6
Study B	0	+0.5	+0.9	+1.2	+0.2

	Employment Outcomes from Different Wage Responses. (Percent of Base-Case Projection for Year)				
	1985	**1986**	**1987**	**1990**	**1994**
'Aggressive' Real-Wage Increases					
Study A	−0.1	−0.2	−0.3	−0.3	−0.6
Study B	−0.3	−0.7	−0.1	−1.4	−2.0
'Moderate' Real-Wage Increases					
Study A	0	−0.1	0	+0.6	+1.8
Study B	0	+0.5	+0.9	+1.2	+0.2

Source: Appendix 20

6.5 Possible Employment Outcomes Resulting from the Interaction of Other Macroeconomic Factors and Productivity Improvements

As reported in the preceding section, the simulations suggest that at the macroeconomic level the employment outcomes from productivity improvements resulting from technological change can be influenced by the behaviour of participants in the setting of prices and wages. In this section we report that other factors, such as the use of monetary and fiscal levers, can also affect the extent and nature of the employment outcomes accompanying productivity improvements and technological change.

One of the studies we commissioned has examined the outcomes resulting from alternate monetary and fiscal responses to productivity improvements, and has concluded that these are important factors in determining the employment impacts of technological change. The study concludes that the responses of the Bank of Canada can have a major effect on the employment impact accompanying productivity improvements. The study suggests that monetary and exchange rate policy has the power to transform the results of enhanced productivity into inflation-fighting at the cost of some unemployment, or into greater growth which may lead to employment gains. In regard to fiscal measures, the study suggests that across-the-board fiscal policy, such as general tax cuts, do not have a major effect on the employment outcomes accompanying productivity enhancement, but does, however, suggest that productivity improvement on its own will lead to a sizeable reduction of government deficits.

Table 6.3 **Sharing the Productivity Dividend: Range of Possible Employment Outcomes Which Could Result from Alternative Responses to Additional Productivity Improvements**

	Possible Employment Outcomes (Percent of Base-Case Projection for Year)				
	1985	**1986**	**1987**	**1990**	**1994**
'Upside' Outcome					
Study A	0	0	0.3	1.4	3.8
Study B	0	0.5	0.9	1.2	0.2
Average A and B	0	0.3	0.6	1.3	2.0
'Downside' Outcome					
Study A	−1.0	−2.2	−3.1	−4.9	−5.8
Study B	−0.5	−1.2	−1.7	−2.9	−4.2
Average A and B	−0.8	−1.7	−2.4	−3.9	−5.0

NOTE The 'Upside' scenario assumes a flexible corporate pricing strategy, a moderate real wage-gain strategy for labour, and accommodating monetary and fiscal responses.

The 'Downside' scenario assumes a sluggish corporate pricing strategy, and an aggressive real wage-gain strategy. These scenarios are more fully described in the source studies.

Source: Appendix 20

6.6 A Summary of Possible Employment Outcomes Resulting from Productivity Improvements and Technological Change

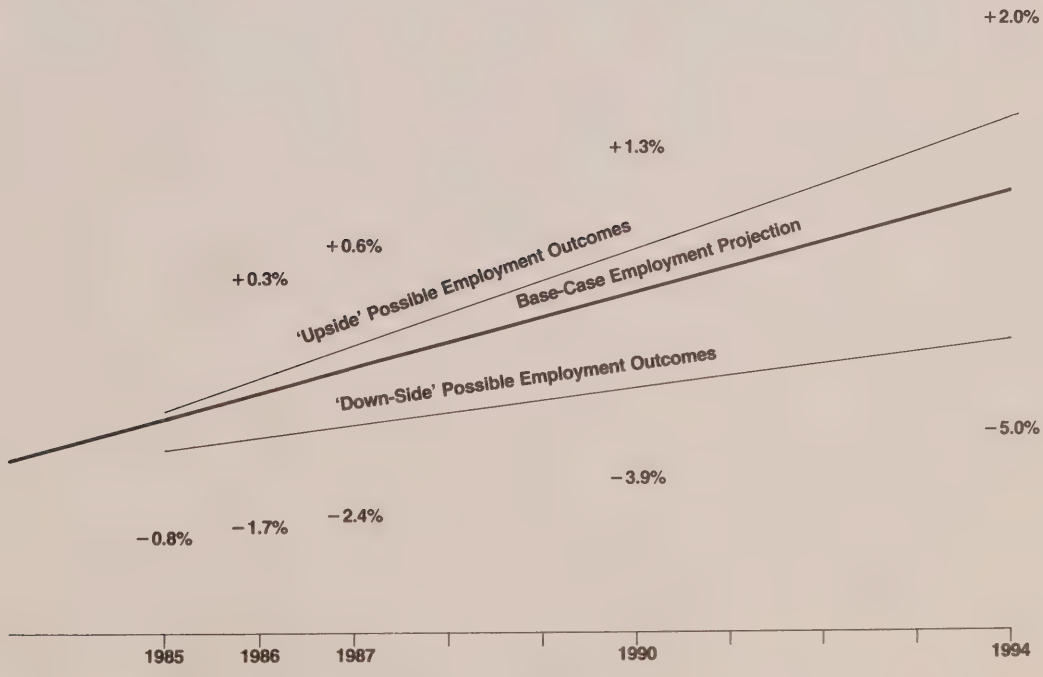
The simulations done by our researchers clearly show that the employment outcomes which accompany productivity improvements and technological change, when viewed at the level of the overall economy, depend very much on how the dividends are distributed in the economy.

The various model simulations performed for us suggest a range of employment outcomes are possible with additional productivity enhancement, and these results have been summarized in Table 6.3 and Figure 6.1. The 'Downside' outcomes are based on a situation of sluggish corporate pricing, and aggressive real wage bargaining by labour. The 'Upside' case has been generated by presuming innovative employment-creation responses of real wage setting and corporate pricing, and accommodating monetary and fiscal responses. This case shows the creation of significant additional employment. In effect, this case represents the results possible if business, labour and government all made contributions toward the use of the productivity dividends for increased job creation.

As we earlier observed, we do not know what the responses of business, labour, government, or other factors might be to circumstances of increased productivity improvements and technological change. Certainly, we do not presume to suggest what their responses should be. Our interest in these studies is simply to examine what range of employment outcomes could possibly result.

From the perspective of the overall economy what we can conclude from these studies is that the employment outcomes of productivity improvements and technological change should not be thought of as being indelibly associated with the nature of the productivity improvements and technological changes themselves, but as being heavily influenced by the actions of key participants in the economy as

Figure 6.1 **Sharing the Productivity Dividend: Range of Possible Employment Outcomes which could result from Alternative Responses to Additional Productivity Improvements**
(Percent of Base-Case Employment Projection for Year)



Source: Appendix 20

changes are implemented. In that sense, it should come as no surprise for us to discover that the extent and nature of the employment outcomes from technological change in the overall economy are not determined in a 'game-plan' that has already been written, but are heavily influenced by the future actions of people who will affect and be affected by the introduction and adoption of new technology.[20]

20 These results have been used in our industry-sector occupational employment studies. The ranges of overall employment outcomes: +0, −1 percent; +1, −4 percent; +2, −5 percent of total employment, in the years 1985, 1990, 1995 respectively, as approximate outcomes in Table 7.2, have been used as estimates of total employment uncertainties connected with technological change. In Appendix 19 to this Final Report, an examination has been conducted of the effects which variations of total employment in these ranges would have on occupational employment estimates.

List of Figures

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List of Appendices*

* The Appendices to the Final Report have been prepared as separate, individually-bound documents.